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Abstract

A simple random sampling technique was used to select 100 extension officers in North West Province, South Africa. Data on knowledge levels and perceived effect of ecosystem services and valuation on extension delivery were collected and analyzed using percentages. The results show that a wide range of knowledge levels exists on ecosystem services and valuation issues and that extension services should change from a generalist approach to a specialist approach; “extension messages should incorporate ecosystems service information”; extension agents would benefit from “increase[s] in extension research skill” and “use of multimedia strategy”; users require new skills; “extension officers need...new training” and “extension messages should address vulnerability of ecosystem services” in response to ecosystem services and valuation issues. The results have several implications for training and educating extension officers in the areas of ecosystem services used for tourism, hedonic pricing, and governance of ecosystem services.

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Introduction

The need for increasing food production to feed the world's population of nine billion people by 2050 has intensified pressure on agricultural production systems, and there are also increasing expectations and needs that cultivation practices be sustainable. However, expansion of areas under cultivation and exploitation of additional natural resources for future increases in agricultural production and rural income have become unpopular as compared with system intensification. Braimoh et al. (2010) state that "agriculture continues to experience a crisis influenced by rapid financial, and structural changes and with enormous influence on ecosystem health" (pp. 5–10).

Nature has independently or through human interference provided valuable goods and services which, due to increasing human demand and economic neglect, has resulted in a high rate of deterioration of many ecosystem services. There is a "disproportion between direct reliance and the capacity to compensate for ecosystems services by the world's poor" (World Resources Institutes [WRI], 2005, p. 225). The "link between human well-being and ecosystem services is gaining increasing global recognition" (Millennium Ecosystem Assessment [MEA], 2005, p.12).

Boyd & Banzhaf (2006) defined ecosystem services as components of nature used to support and improve human well-being (p. 6). Ecosystem components include surface water, oceans, vegetation types, and species resources, while biological, chemical, and physical interactions between ecosystem components are ecosystem processes and functions. Obtaining measures of importance and worth by estimating the amount people are willing to pay to preserve or enhance ecosystem functions constitutes the ecosystem services valuation process (p. 10). Values are

categorized as *use* and *non-use*, or "passive use," values. Bateman & Willis (1999) stated that "use values is the actual use of the environment, while non-use values are those not associated with actual or alternative use of an ecosystem or its services" (p. 30).

A major component of interventions in developing countries is payment for ecological services generated by specific land uses (World Bank, 2005); however, empirical evidence on what these values might be is mixed (Kaimowitz, 2001). The blueprint for ecosystem service conservation does not exist in many countries, even when such exists for biodiversity conservation (Balvanera et al., 2001). "Ecosystem services management should integrate biophysical, economic and political factors that will mediate access and apportion resources among competing users" (Costanza et al., 1997, pp. 30–35). Methods of management should measure the costs of ecosystem services conservation to various user groups (Turner et al., 2003), as well as trade-offs inherent to the maintenance of ecosystems (Chan et al., 2006).

Boone et al. (2007) stated that "the need to keep the productive capacity of natural resources relative to population growth and economic demands while protecting and restoring environmental quality has stressed the concept of sustainability" (p 5). "The sustainability challenge is that educators and farmers as well as stakeholders in the agriculture value chain should examine the effects of practices, interactions and the ever changing agricultural systems in the long-run" (p. 6). Through the process of continuous experimentation and the use of different farming strategies, agricultural stakeholders are attempting to reach sustainability in their operations, environments, and communities. Boone et al. (2007) report that there is need for a continuous network of information,

new technologies, and innovations for farmers who practice sustainable agriculture to be successful in managing their farmlands (p. 6).

Agunga (1995) noted that “extension not only has a long history of service to farmers and thus extension officers must be abreast of the latest agricultural research and technology that will enable them to understand the needs and problems of their clientele” (p. 169). The existing public and private extension frameworks, “have responsibility for the promotion of sustainable agriculture education; this is however contingent, on the conviction of the value of sustainability by extension agents before they can introduce the concept to farmers successfully” (p. 180). Agricultural extension is the most important source of information to farmers in most African countries (Agbamu, 2002) and plays a significant role in affecting farmers' adoption of innovations (Van den Ban & Hawkins, 1988). Agricultural extension programs are very diverse in international contexts as they are managed variously as public sector agencies (most common), non-governmental organizations (NGOs), and by private firms and private organizations. An equally important variation occurs in the skill and competence of extension staff (Oladele & Sakagami, 2004). The effectiveness of extension service delivery is critically dependent on the knowledge of extension officers about the various agricultural innovations they disseminate to farmers. Extension officers' knowledge will influence their attitude and the kind of awareness they create about ecosystem services and valuation among farmers. Long and Swartzel (2007) noted that in order to meet farmers' needs and enable them to make informed decisions about their economic, social and cultural well-being, extension services must provide research-

based information, educational programs and technology.

Purpose and Objectives

The purpose of this study was to determine knowledge levels and perceived effect of ecosystem services and valuation on extension delivery in North West Province, South Africa. The specific objectives of the study were to:

1. Identify the personal characteristics of extension officers
2. Determine extension officers' knowledge of ecosystem services and valuation techniques
3. Ascertain the perceived effect of ecosystem services valuation on extension message delivery

Methods

The study was carried out in North West province, South Africa. The study population was all the extension officers (200) in the province. Extension officers in this study are employees of the Department of Agriculture who have the responsibility of providing information to farmers on all aspect of farming. A simple random sampling technique was used to select 100 extension officers from whom data were collected. Frame error was controlled by excluding administrative and support staff, while selection error was eliminated by ensuring that all frontline extension (field officers) was contacted for the study. A structured questionnaire was developed based on the study objectives and related literature, which was divided into three parts. The first sought demographic characteristics of extension officers, and the second elicited information on extension officers' knowledge, sub-divided into *ecosystem services* (40 items), *valuation* (15 items), and *sustainability and vulnerability*

(20 items). This knowledge was anchored as correct (2) or incorrect (1). The scoring was reversed for negative statements. The overall minimum score on the knowledge scale is 75, while the maximum score is 150.

The third section of the questionnaire measured perceived impact of ecosystem services and valuation on extension delivery (25 items) on a 3-point scale of high (3), medium (2), and low (1). The minimum and maximum scores on the impact scale were 25 and 75, respectively. The questionnaire was validated by lecturers from the Department of Agricultural and Extension at North West University, and their suggestions were incorporated into the instrument before data collection. The questionnaire had an overall reliability coefficient of .90 determined by the split-half technique. Reliability coefficients for the different sections of the questionnaire were *ecosystem services* (.75), *valuation* (.80), *sustainability & vulnerability* (.85) and *impact on extension delivery* (.92). Non response error was controlled through call-backs and follow-ups on the questionnaire. Data obtained were analyzed with the Statistical Package for Social Sciences (SPSS) using percentages.

Results

Personal Characteristics of Extension Officers

Of extension officers in the study, about 63% are male, and their mean age was 44 years. About 75% were married and 84% were Christians. In terms of educational qualification, 875 of the extension officers held a diploma in agriculture, with a mean of 12 years working experience. About 87% live in their job location, notwithstanding whether it is rural or peri-urban. This agrees with the findings of Oladele and Tekena (2011) and Zwane (2009), who reported that extension officers in North-West and Limpopo provinces of South Africa were

mainly males, between 40 to 49 years, and held a diploma as their educational qualification. Bembridge (1991) also reported similar findings in terms of the personal characteristics of extension officers in South Africa.

Knowledge of Ecosystem Services

Knowledge of a concept, tool or innovation occurs when an individual knows both its function and application (Rogers, 1995). The knowledge of ecosystem services is particularly associated with the sources, types, and benefits to mankind (MEA, 2005). Its application or “how-to” knowledge begins with the understanding of the examples and activities related to ecosystem services. In this paper, prominent ecosystem services knowledge demonstrated by extension officers in the study area included “ecosystem services are benefits derived from natural resources” (97%); “examples of ecosystem services are water bodies, watershed, forest land” (96%); “ecosystem services provision services include water” (96%); “ecosystem services provision services include hydropower biomass fuel” (98%); and “ecosystem services enhances carbon sequestration” (90%) (Table 1). Al-Subaiee, Yoder and Thomson (2005) reported that extension agents in Riyadh region of Saudi Arabia had a positive perception towards sustainable agriculture concepts and that the perception provides a basis for sustainable agriculture development. Conversely, extension officers had low performance on ecosystem services knowledge such as “wax and gums from trees are an example of ecosystem services” (50%); “honey is an example of ecosystem services” (46%); “ecosystem services include hiking” (40%); “ecosystem services include angling” (57%), and “ecosystem services include swimming” (58%). The concept of ecosystem services became more prominent when the Millennium

Table 1: Knowledge Level of Extension Officers Regarding Ecosystem Services (n=100)

Items	Correct	Incorrect
Ecosystem services provision services include hydropower, biomass fuel	98*	2
Ecosystem services are benefits derived from natural resources	97	3
Examples of ecosystem services are water bodies, watershed, forest land	96	4
Ecosystem services provision services include water	96	4
Ecosystem services create opportunity for recreation	92	8
Ecosystem services enhances carbon sequestration	90	10
Water shed is an example of ecosystem services	89	11
Biodiversity conservation is a benefit from ecosystem services	87	13
Non-timber forest products is an example of ecosystem services	83	17
Natural resources are not invulnerable and infinitely available	83	17
Rotational landscapes simulates ecosystem services	83	17
Many livelihood activities depend on ecosystem services	83	17
Tree plantations simulates ecosystem services	83	17
Ecosystem services provision services include crops, wild foods, spices	82	18
Forest plantation simulates ecosystem services	81	19
Environmental Impact assessment is important to conserve ecosystem services	79	21
Ecosystem services create opportunity for tourism	79	21
Ecosystem services include mitigation of droughts and floods	78	22
Ecosystem services include generation, preservation and renewal of soils fertility	78	22
Orchards simulates ecosystem services	78	22
Ecosystem services help in climate change mitigation	78	21
Ecosystem services include cycling and movement of nutrients	76	24
Ecosystem services include detoxification and decomposition of wastes	75	25
Ecosystem services include birding	74	26
Ecosystem services include pollination of crops and natural vegetation	74	26
Ecosystem services help conserve genetic resources	74	26
Ecosystem services include control of vast majority of potential agricultural pests	72	28
Agro forestry systems simulates ecosystem services	72	28
Ecosystem services help in biological control	71	29
Ecosystem services increases organic carbon deposit	70	30
Carbon projects enhances ecosystem services	70	30
Ecosystem services is one of the Millennium Development Goal focus	69	31
Ecosystem services provision services include pharmaceuticals, biodiversity	69	31
Ecosystem services include dispersal of seeds	67	33
Ecosystem services include hiking	60	40
Ecosystem services include purification of air and water	60	40
Honey is an example of ecosystem services	54	46
Wax and gums from trees are an example of ecosystem services	50	50
Ecosystem services include angling	43	57
Ecosystem services include swimming	42	58

*Figures are percentages

Development Goals were introduced but has often been covered under broad discussions of sustainable agriculture; the focus being on the practices that will not jeopardize the resources for future generation. Karami and

Hayati (1998) and Chizari, Karbasioun, and Linder (2006) reported that agricultural extension professionals and experts in Iran had problems understanding the concept of sustainability in agriculture. Chizari,

Karbasioun and Lindner (1998) noted that the ability to plan and execute effective educational programs and other technology transfer activities by extension will be seriously limited without an adequate number of well-trained agents. Erbaugh, Kibwika and Donnermeyer (2007) noted that extension agents in Uganda had training needs regarding integrated pest management (an integral part of ecosystem service management).

Knowledge of Ecosystem Services Valuation

The conceptual knowledge base for ecosystem valuation is complex and multidimensional (Chan et al. 2006); fifteen items were combined into a rating scale to measure extension officers' knowledge. The coefficient of reliability for knowledge of ecosystem valuation was 0.85, indicating an acceptable level of reliability (Nunmaly, 1978). From the valuation of ecosystem services in Table 2, extension officers had high knowledge of items such as: "ecotourism is a business opportunity created by ecosystem services" (85%); "economic valuation of ecosystem services will encourage social responsibility" (85%); "ecosystem services is refer to as Green GDP"(80%) and "economic valuation of ecosystem services will encourage environmental management" (82%); however, low knowledge scores were recorded for "hedonic pricing of ecosystem services reflects the price people will pay for associated goods." Martin-Lopez, Montes, and Benayas (2007) reported that personal behavior and knowledge of ecosystem importance influenced the willingness to pay for sustaining ecosystem services provided by biodiversity in Donana, Spain. Cai and Smit (1994) alluded to the capacity and capability of extension staff to influence the integration of climate and weather

information into agricultural production and natural resource management. Hagmann, Chuma, and Murwira (1996) stated that agriculture extension officers need a change of role from "teachers" to "facilitators" to be effective with appropriate tools to promote sustainable agricultural practices (including climate/weather) in extension strategies (Düvel & Botha, 1999).

Knowledge of Ecosystem Sustainability and Vulnerability

Knowledge and awareness are generally considered prerequisites to adoption of new technologies, and change agent success in securing adoption is related to clients' perception of change agent credibility (Rogers, 1995). Change agent credibility is linked to clients' perceptions of change agent knowledge and technical competence. Thus, extension agent knowledge is a vital link in the implementation of conservation of ecosystem services. In terms of ecosystem sustainability and vulnerability, prominent items with correct responses among extension officers included "user associations are important in ecosystem services" (88%); "there is increasing vulnerability of ecosystem services" (88%); and "the sensitivity of ecosystem services is high"(90%) (Table 3). On the other hand, extension officers indicated low knowledge on items such as "ecosystem services is well managed by the government"; "ecosystem services is well managed by local institutions"; "multi-use situations determines ecosystem services form of governance"; and "multi user situations determines ecosystem services form of governance." Extension agents in Ohio, Pennsylvania, Virginia, and West Virginia indicated that sustainable agriculture was a priority for future clientele interactions and that it was socially acceptable,

Table 2: Knowledge Level of Extension Officers Regarding Ecosystem Valuation (n=100)

Items	Correct	Incorrect
Ecotourism is a business opportunity created by ecosystem services	85*	15
Economic valuation of ecosystem services will encourage social responsibility	85	15
Ecosystem services is refer to as green GDP	82	18
Economic valuation of ecosystem services will encourage environmental management	80	20
Ecosystem services valuation of involves social communication and information	79	21
Ecosystem services has economic values	78	22
Economic valuation of ecosystem services will create business opportunities	74	26
Replacement cost is the cost to replace services with manmade systems	72	28
Avoided cost of ecosystem services allow society to avoid costs that would have been incurred in the absence of those services	69	31
Travel cost of ecosystem services reflects the implied value of the service	66	34
Factor income is the services provided for the enhancement of incomes	64	36
Contingent valuation reflect the cost to be paid for hypothetical scenarios of alternatives to ecosystem services	62	38
Hedonic pricing of ecosystem services reflects the price people will pay for associated goods	56	44

*Figures are percentages

Table 3: Knowledge Level of Extension Officers Regarding Ecosystem Sustainability and Vulnerability

Items	Correct	Incorrect
The sensitivity of ecosystem services is high	90*	10
There is increasing vulnerability of ecosystem services	88	12
User associations are important in Ecosystem services	88	12
Over exploitation of ecosystem services leads to unsustainable development	87	13
Deforestation is not ecosystem services conservation	86	14
Ecosystem services are threatened by human activities	83	17
Depletion of ecosystem services increases vulnerability of users to poverty	81	19
Adaptation involves capacity and resilience of ecosystem services	76	24
Environmental impacts of anthropogenic action affect ecosystems	77	23
Land degradation is not ecosystem services conservation	76	24
Ecosystem health is conservation of natural resources	74	26
Desert encroachment is not ecosystem services conservation	71	29
Industrialization hinders ecosystem services conservation	71	29
Stakeholders platforms enhances ecosystem services management	69	31
Participatory approaches are important for ecosystem services management	68	32
Vulnerability assessment reduce effect of ecosystem services depletion	66	34
Multi user situations determines ecosystem services form of governance	48	52
Multi-use situations determines ecosystem services form of governance	47	53
Ecosystem services is well managed by local institutions	42	58
Ecosystem services is well managed by the government	40	60

*Figures are percentages

environmentally sound, and economically feasible (Boone et al. 2007). According to Buford, Bedeian, and Lindner (1995), the importance of an effective staff training program for extension agents becomes evident when considering challenges facing extension agents in the learning of new skills to maintain their proficiency or become qualified for promotions.

The effect of extension officers' perceptions of how ecosystem services and valuation issues will impact extension

delivery presented in Table 4 were rated on a 3-point scale of high, medium, and low and consisted of 25 items. Extension officers indicated that climate change would have high impact in terms of "extension services should change from generalist approach to specialist" (71%); "extension messages should incorporate ecosystems service information" (64%); and the need for an "increase in extension research skill" (62%) and "use of multimedia strategy" (60%).

Table 4: Knowledge Level of Extension Officers Regarding Ecosystem Services and Valuation on Extension Service Delivery (n=100)

Items	High	Medium	Low
Extension services should change from generalist approach to specialist	71*	20	9
Extension messages should incorporate ecosystem service information	64	24	11
Increase in extension research skills	62	26	12
Use of multimedia strategy	60	28	12
Extension has to be abreast of new discoveries in agriculture	58	28	14
Extension officers' knowledge on ecosystem services should change	58	37	5
Extension messages should address carbon sequestration practices	57	27	16
Extension messages should address genetic erosion	57	35	8
Use of rural radio, community radio and FM stations	56	32	12
Extension messages should address changing water use efficiency	56	28	16
Extension messages should address users coping strategies with climate change	55	36	9
Attitude towards coverage of ecosystem services	55	37	8
Media coverage of ecosystem services	53	35	12
Users need of new training	52	24	24
Extension officers exposure to new technology	51	35	14
Extension messages should address changing and diversified livelihoods	51	36	13
Users will need specialized and privatized extension	50	33	17
Extension messages should address vulnerability of ecosystem services	48	40	12
Users require new methods of coping with their livelihoods	47	41	12
Extension officers require new skills	46	41	13
Extension messages should address changing irrigation efficiency	46	40	14
Users exposure to new technology	44	27	29
Increase in proportion of ecosystem service information in extension messages	41	45	14
Extension officers need of new training	36	45	19
Users require new skills	30	52	18

*Figures are percentages

Moderate impact was indicated for items about users requiring new skills (52%); “extension officers need[ing] training” (45%) and whether “extension messages should address vulnerability of ecosystem services” (40%). Milburn, Mulley, Susan, and Kline (2010) noted that “extension messages need to cover issues that include land assessment, wetland and woodlot management, new forms of sustainable economic development such as tourism, and conservation and stewardship to increase public awareness and support” (p. 7) On the contrary, extension officers reported that ecosystem services and valuation would have low impact on “users’ exposure to new technology.” Extension agents in Ohio, Pennsylvania, Virginia, and West Virginia indicated that research skills on sustainable agriculture were still in their infancy. Karami (1995) wrote that perceptions, attitudes, educational training, and beliefs of extension agents are major factors affecting the issue of sustainable agriculture education in Iran. Hersman (2004) reported that the knowledge level of extension agents determines the amount of information the agents offered to their clientele. Milburn, et al. (2010) noted that the role of extension agent as a partner in the research process increases both the relevance and impact of extension.

Conclusion, Recommendations and Implications

The future of agricultural production due to its dependence on natural resources has made ecosystem services and valuation critical. Extension, as a major source of information to farmers, plays important roles in educating farmers on how to respond to ecosystem services and valuation issues. Using a survey of extension officers in North West Province, South Africa, this paper has added to the existing literature by providing evidence to show that extension

officers’ knowledge about ecosystem services and valuation is influenced by personal characteristics.

Without sound human capacity to understand and train end-users, ecosystem services loss will continue to be a major contributor to food insecurity. The multifaceted nature of ecosystem services and the many scientific and technological processes involved require training and capacity development at all levels, particularly for extension officers who act as a link and facilitate between policy, research and end-users (Milburn, et al. 2010).

From the findings of this study, extension officers displayed a wide range of knowledge levels regarding ecosystem services issues related to ecosystem services, valuation, sustainability, and vulnerability but recognized extension services should change from a generalist approach to a specialist approach. They also recognized that “extension messages should incorporate ecosystems service information”, the importance of “increase in extension research skill,” and “use of multimedia strategy”; that users require new skills and “extension officers need... new training”; and that “extension messages should address vulnerability of ecosystem services” in response to ecosystem services and valuation issues. Paulso (1995) stated that Minnesota extension agents varied considerably in terms of knowledge, views, openness and involvement in alternative agriculture.

Erbaugh et al, (2007) stated that frontline extension agents are vital to program implementation because they provide the necessary links with farmers and communities, manage on-farm research efforts, and deliver education and training programs. However, many have identified frontline extension agents’ lack of awareness and understanding of natural resources management as an impediment to effective

transfer of strategies to farmers (Yudelman et al., 1998; Zalom, 1993). The results have several implications for training and educating extension officers in ecosystem services and valuation issues. The specific areas include the identification of ecosystem services related to tourism, hedonic pricing, and the multi-stakeholder governance of ecosystem services. Extension officers should work proactively rather than reactively, because of the large number of clients and the economic impact of ecosystem services and valuation. It is also important that extension curriculum address contemporary issues in agriculture, including ecosystem services and valuation.

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