Journal of Agricultural Extension and Rural Development

Volume 8 Number 3 March 2016

ISSN 2141-2170

Academic Journals

ABOUT JAERD

The Journal of Agricultural Extension and Rural Development (JAERD) is published monthly (one volume per year) by Academic Journals.

Journal of Agricultural Extension and Rural Development (JAERD) is an open access journal that provides rapid publication (monthly) of articles in all areas of the subject such as Impact monitoring and evaluation system for farmer field schools, Metals in bio solids-amended soils, Nitrogenous fertilizer influence on quantity and quality values of balm, Effect of irrigation on consumptive use, water use efficiency and crop coefficient of sesame etc.

The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published shortly after acceptance. All articles published in JAERD are peer-reviewed.

Contact Us

Editorial Office: jaerd@academicjournals.org

Help Desk: helpdesk@academicjournals.org

Website: http://www.academicjournals.org/journal/JAERD

Submit manuscript online http://ms.academicjournals.me/

Editors

Editorial Board

Journal of Agricultural Extension and Rural Development

Table of Contents: Volume 8 Number 3 March, 2016

ARTICLES

academicJournals

Vol.8(3), pp. 19-28, March 2016
DOI: 10.5897/JAERD2014.0609
Articles Number: 57169F256993
ISSN 2141-2170

http://www.academicjournals.org/JAERD

Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Identification of Field crop structure and production constrains with special consideration of gender aspect of resource poor farmers in north Kordofan state of Sudan

Yasir A. Gamar, Omer A. Bakhit, Hatim G. Murdi, Tarig E. Ahmed, Abdelatif A. Suliman, Adil Y. Yagoub and Elgailani A. Abdalla*

Elobied Research Station, Agricultural Research Corporation (ARC), Elobied, North Kordofan State, Sudan.

Received 1 May, 2015; Accepted 23 July, 2015

Sudan is one of the largest countries in Africa ranks third after Algeria and Democratic Republic of the Congo. Agriculture in the country is divided into high rainfall and dry land agriculture. Dry land agriculture production and productivity described as low input agriculture comparing to high rainfall agriculture but no or little information discussing field crop structure, yield of food crops, production constrains and the seed system. Therefore the study aimed at providing essential information of the field crop structure and major field production constrains for resource poor farmers in North Kodofan. Two localities, Sheikan and Elrahad were selected. The study was carried out using descriptive method. Data were collected from farmers using semi structured dialogue, stakeholder identification and flow chart, brain storming and historical graph of the community tools which links different issues in time and helps the participants to identify variety characteristics, and major field production constrains and farmer situations with special considerations for women farmer needs. The study identified; sorghum, pearl millet, sesame, ground nut, hibiscus, cow pea, okra, water melon, snake cucumber as main cultivated crops in Sheikan and Elrahad localities of North Kordofan in Sudan.

Key words: Crop production constrains, participatory tools, resource poor farmers, North Kordofan, Sudan.

INTRODUCTION

Agriculture is the most important activity in Sudan. The arable agricultural land is 97.5 million hectares (FAO, 2013). The cultivated land remains 16.7 million hectare after separation of Southern Sudan in 2011. Regardless the deterioration in the share of agriculture in total exports from 73% in 1998 to 5% in 2008, due to the increase in oil exports, agriculture remains an important sector in the Sudanese economy. It contributed an annual average of 45% to total GDP during the last ten years in addition to its employment of about 80% of the

*Corresponding authors. E-mail: gamarotta@yahoo.com; elgailani_ers@hotmail.com.

total labor force including agricultural-related activities (Siddig, 2009).

In the country, poverty remains a rural phenomenon, and within the rural areas it is closely associated with the livelihood systems of rain-fed agriculture. FAO (2011) showed 66.8 and 33.2% of the population are rural and urban respectively. The draft Interim Poverty Reduction Strategy Paper (I-PRSP) revealed that 46.5% of the population of Sudan is found to fall below the poverty line, with 26.5% of the urban population and 57.6% of the rural population falling below the poverty line (Central Bureau of Statistics (CBS), 2010). FAO/SIFSIA also reported that one of three Sudanese suffered from food deprivation in 2009. The prevalence of under nourishment was 31 and 34% for the urban and rural populations respectively.

Kordofan region is situated in the mid-west of Sudan. It is located between latitudes 9.50 and 16.40 N and longitudes 27 to 32 E. It covers an area of about 380,000 km^2, representing 24% of the total area of the country. Administratively, the region is divided into three states North, South and West Kordofan states. The total population of North Kordofan is estimated to be 4.3 million inhab. The agriculture and livestock are the main activities for most of populations. The production and productivity described as very low of most crops compared to international production average. The production and productivity is described as very low for most crops compared to other parts of the country.

Poor adoption of new varieties and institutional and biotic factors are the production constraints. Metrological data in Sudan monitored no changes in annual amount of rainfall but showed fluctuation in distribution and shortening of the rainfall seasons in the last decade. These climatic changes adversely affect traditional sorghum-growing areas of South North Gadaref, Gezira, Sennar, Damazin, White Nile State and North Kordofan, causing a drastic shift towards the south (Mohamed, 2011; Abdalla and Gamar, 2011). In Sudan, recently erratic and poor distribution of the rainfall was observed which the climatic changes it seems to become a fact. Climate change scenarios indicate that water shortage and shortening of the effective growing season will be increasingly likely in sub-Saharan Africa, increasing the need for short-duration cereals such as sorghum (Abdalla and Gamar, 2011).

In Sudan breeding and adoption of new varieties relied on top down process. The gap between breeding system and farmers led to slow rates of adoption for the new varieties and also farmer needs are not addressed by national breeding programs. Recently, scientists are suggested the participatory approach in breeding programs. Participation is rapidly becoming a catch-all concept, even a cliche (Woelk, 1992). Participatory research methods can be used not only to enable local people to seek their own solutions according to their priorities, but also to secure funding, to co-opt local people into the agendas of others or to justify short-cut research within a top-down process (Rahman and Fals-Borda, 1991; Kidd, 1985). The agricultural production and productivity is largely constrained by natural factors, policy and adoption of technologies (EAC, 2006). These factors might also include farmer needs, adoption rate of released varieties, the weight and role of gender in agricultural activities as well as community aspect which include institutional working modalities and learning ability. In North Korodofan of Sudan no information about the farmer needs, field crop structure and agricultural production constrains.

Therefore, study is aiming to provide basic information for future rural development and participatory varietal improvement and protection. The specific objectives are to identify the major field crop structure and their biotic and a biotic production constrains and the institutional problems for resource poor farmers in North Kordofan state of Sudan.

MATERIALS AND METHODS

Sampling procedure

The survey was carried out in Sheikan and Elrahad localities of North Kordofan state of Sudan. Ten villages were selected, six villages in sheikan locality named Eledade, Fareeg Elbagar, Faris, Elddajo, Sawarda and Wad Akkam and four villages were selected in Elrahad locality named; Gaghror, Warshal, Um Habila and Um Elsheikh. The selected villages within the two localities represented the different ecological and ethno-botanical zones in the North Kordofan state of Sudan (Figure 3).

Community aspect baseline evaluation

In this part following issues was studied:

1. Cultivated crops; past and current cultivated land races and varieties.
2. Identification of wet and dry seasons in the last five years and other crop production constraints (biotic and a biotic).
3. Capacity building of community institutions and traditional community practices crop protection.
4. Indigenous knowledge which can be past and/or currently practiced.
5. Setting up institutional working modalities.
6. Community awareness about new varieties.
7. Adoption of released varieties and new technologies.
8. Role and the weight of informal seed system in crop grain production.

The assessment tools used

The assessment tools used are as follows:

1. Transect walk for visited villages.
2. Historical graph focusing on the dry seasons and the major changes happened (climatic changes focusing in farmer concept of changes in rainfall amount, duration and distribution in last 5 years)
3. Semi structured dialogue.
4. Brain storming to identify future variety characteristics (farmer

Table 1. The crop identification and ranking by Male farmers in Sheikan locality.

Village crop	W. Akkam (Ranking)	F. Albagar (Ranking)	Swarda (Ranking)	Eledade (Ranking)	Elddajo (Ranking)	Faris (Ranking)	Overall ranking
Sorghum	1	1	1	7	1	2	53
Sesame	2	2	4	2	2	3	51
Pearl millet	6	7	2	1	3	1	46
Roselle	4	3	3	3	7	6	41
Ground nut	-	4	-	3	4	4	29
Cowpea	-	8	5	5	6	5	27
Okra	3	6	-	6	-	7	22
Water melon	7	5	-	4	8	8	23
Snake cucumber	-	-	-	-	5	-	6

Ranking:1=10, 2=9, 3=8, 4=7, 5=6, 6=5, 7=4, 8=3, 9=2, and (-) not grown.

Table 2. The crop identification and ranking by female farmers in Sheikan locality.

Village crop	W. Akkam (Ranking)	F. Albagar (Ranking)	Swarda (Ranking)	Eledade (Ranking)	Elddajo (Ranking)	Faris (Ranking)	Overall ranking
Sorghum	1	1	1	7	1	2	53
Sesame	2	2	4	2	2	3	51
Pearl millet	6	7	2	1	3	1	46
Roselle	4	3	3	3	7	6	41
Ground nut	-	4	-	3	4	4	29
Cowpea	-	8	5	5	6	5	27
Okra	3	6	-	6	-	7	22
Water melon	7	5	-	4	8	8	23
Snake cucumber	-	-	-	-	5	-	6

Ranking:1=10, 2=9, 3=8, 4=7, 5=6, 6=5, 7=4, 8=3, 9=2, and (-) not grown.

needs).
5. Stakeholder identification and flow chart for determine the role of informal seed system.

The assessment tools used in this study were performed according to de Boef and Maria (2007) Participatory tools working with crops, varieties and seeds.

Analysis method

The information were collected from the selected villages and analyzed using a descriptive method. The collected information were then structured and interpreted to describe the current status of the field crops and the community aspects.

RESULTS

The field crop ranking and structure

The study identify sorghum, sesame, ground nut, pearl millet, roselle, cowpea, okra, water melon, snake cucumber as main cultivated crops in Sheikan locality of North Kordofan in Sudan (Tables 1 and 2).

The identified crops were ranked by male farmers as; sorghum, sesame, pearl millet, roselle, ground nut, cowpea, okra, water melon and snake cucumber, while the female farmers rank as; sorghum, roselle, sesame, pearl millet, okra, ground nut, cowpea, water melon and snake cucumber in Sheikan locality of North Kordofan in Sudan (Tables 1 and 2).

The semi structured dialogue with farmers discussing the history of cultivated crops showed pearl millet continues production deterioration has led to decrease in area covered with the crop. Also the result showed maize and bambara groundnut (*Vigna subterranea*) were disappeared from the field crop structure due to continuous failure.

The field crops in male and female farms showed no differences of presence and absence of field crops. The result showed absence of ground nut and cowpea in W.Akam village and ground nut, okra and water melon in Swarda village. When cucumber grown by female and

Table 3. The crop identification and ranking by farmers Elrahad Locality.

Village crop	Um Habila (Ranking)	Warshal (Ranking)	Gaghror (Ranking)	Um Elsheikh (Ranking)	Overall ranking
Sorghum	1	1	1	2	39
Sesame	2	2	2	3	35
Pearl millet	1	7	3	1	32
Ground nut	3	2	4	5	30
Roselle	4	3	4	4	29
Okra	5	6	4	6	23
Cowpea	6	5	4	-	18
Water melon	7	4	-	-	11
Snake cucumber	-	-	-	7	4

Ranking: 1=10, 2=9, 3=8, 4=7, 5=6, 6=5, 7=4, 8=3, 9=2, and (-) not grown.

male in farmers only in Alddago village in Sheikan locality of North Kordofan in Sudan (Tables 1 and 2).

The study identify sorghum, sesame, ground nut, pearl millet, roselle, cowpea, okra, water melon, snake cucumber as main cultivated crops in Elrahad locality of North Kordofan in Sudan (Table 3). It showed no separate farms for male and females only family farms and collective actions for achieving field activities. The field crop ranking as identified; sorghum, sesame, pearl millet, ground nut, roselle, cowpea, okra, water melon and snake cucumber, in Elrahad locality of North Kordofan in Sudan (Table 3).

The semi structured dialogue with farmers showed the pearl millet production continues deterioration has led to decrease in area covered with the crop. Also the result showed maize (Zea mays) and bambara groundnut (Vigna subterranea) were wiped-out from the field crop structure due to continuous failure. The results showed sorghum, sesame, pearl millet, roselle, ground nut and okra cowpea and water melon are cultivated annually during the rainy season, when cucumber showed only present in Um Elsheikh village at Elrahad locality of North Kordofan in Sudan (Table 3).

Biotic and a biotic production constrains

To investigate the productions constrains first we asked farmers to emphasize the major production constrains and farmers identified: Drought is the major a biotic constraint in the two localities. Through structured dialogue, water shortage was discovered to be the main factor of crop failure. Striga was mentioned to be the major parasitic weed devastating sorghum and pearl millet while birds cause high loss in production of the crops during the grain filling. In insect pest, the millet earhead caterpillar (*Rhaguva albipunctella*) cause considerable loss to pearl millet production. Several polyphagous insects, such as locusts and grasshoppers (Schistocerca gregaria, Locusta migratoria and Chrotogonus spp.), army-worms (*Mythimna* spp. and *Spodoptera exempta*) and *Heliothis armigera*, sporadically cause severe damage in pearl millet. In plant diseases, smut diseases cause serious damage to sorghum and pearl millet production especially for non treated seeds with fungicide.

In sesame the late maturing varieties and delaying of weeding operations lead to low production and occasionally in a complete crop failure. In oil seed crops; the results revealed *Antigastra catalaunalis* as a major insect pest to sesame production also ground nut showed emergence of termites in dry seasons. In ground nut white ant were identified as major biotic constrains to production. Roselle has post harvest flies disturb the labours of peeling of the sepals. Some bruchids infest cowpeas and make significant damage on stored crop. Cultivation of water melon was also discovered to be threatening by bug which causes damage leading to plant death.

Identification of wet and dry season in the last five years as indicators for rainfall succession and fluctuation, the result revealed in Figure 1 ratio 43:57 for dry/wet seasons, the result revealed Fareeg Albagar village showed less dry/wet seasons 1:4, while Faris and Eladade showed high ratio (3:2) of dry/wet seasons (Figure 1) at Sheikan locality. The dry/wet ratio showing probability of wet and dry seasons relatively equal (Figure 1). In identifying wet and dry season in the last five years as indicators for rainfall succession and fluctuation, the result showed ratio of 50:50 for dry/wet seasons, Um Habeila village showed less dry/wet seasons 2:3, when Um Elsheikh 3:2 and Gaghror showed high ratio 2:3 of dry/wet seasons (Figure 2). Also the result showed high fluctuation of wet and dry seasons with mean equal chances for dry and wet seasons (Figure 2).

Current and past cultivated land races

The results showed considerable level of crop and

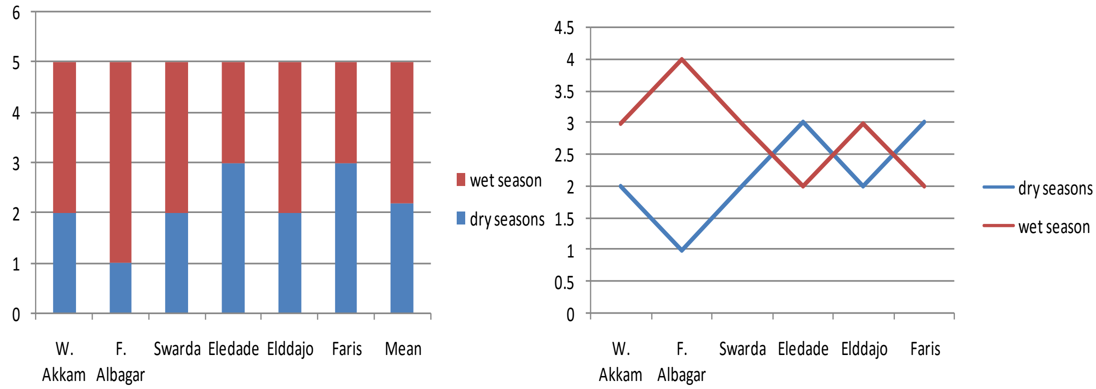

Figure 1. The wet and dry seasons in the last five rainy seasons in six villages of Sheikan locality of North Kordofan state.

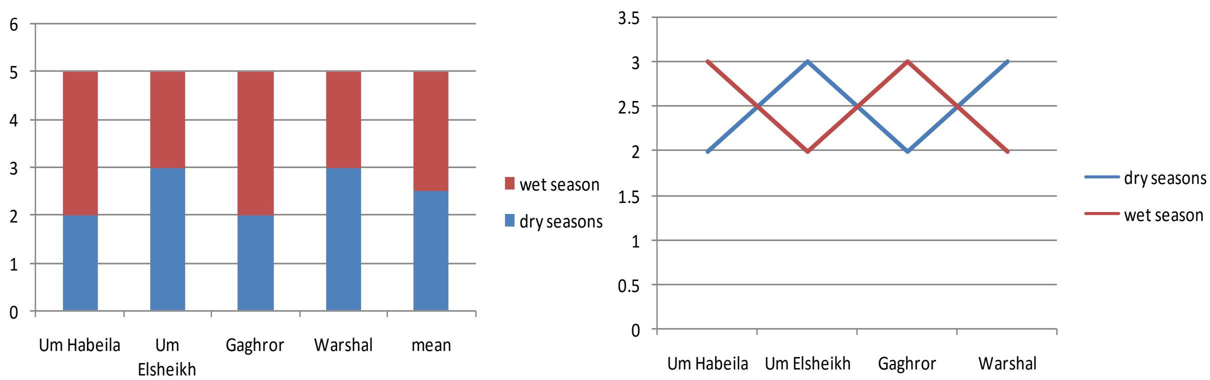

Figure 2. Fluctuation of the dry and wet seasons of the last five rainy seasons in the four villages in Elrahad locality of North Kordofan state.

varietal diversity in both localities (Tables 4 and 5). Elrahad locality is diverse in roselle. The recorded information in both localities for all field crops is highly dependent on local material with some exceptions in Faris village for sorghum and ground nut. The results showed number of farmer varieties previously grown as; Zinary, Korakolo, Naggad, Swmeet, Banat Elzamn, Wad Bargo, Fetarita, Seidairy, Elzole Mno, Gaddoum Eltitle, Wad Elfhal and Wad Elgusari. But at present only; Zinary, Fetarita, Arfa Gadamak are grown while the rest are not cultivated. The identified released varieties by national research centre and delivered to the farmer such as; Butana, Yarwasha, Wad Ahmed, Tabat, and Gadam Elhamam sorghum varieties.

Stakeholder identification and role of informal seed system

The stakeholder indentified local leaders, household, and local markets constituting the farmer sources of new technologies. The farmers highly relied on local material in both localities which produced annually from their farms and kept in the storage. The seeds flow from farmer to farmer, neighbour village to another and local market. In some areas where linked before to NGO's, governmental stakeholder as research institutes, extension they showed better understanding and willing to collaborate. Also, the local community have information of released technologies. On other hand, the brain storming result showed the level of farmer participation never goes beyond functional participation.

Field crops productivity

The semi structured dialogue and brain storming with farmers led to identify the use of intercropping system in plant husbandry. Also the farmers to tackle crop production constrains they dependant on inter cropping system which makes determination of the crop yield is very difficult. Field crops productivity estimated the rate

Table 4. The cultivars identified by farmers, Sheikan locality.

Village	Crops	Past grown cultivars	Present grown cultivars
Faris	Sorghum	Wad Bargo, Swmeet, Banat Elzamn, Zinary and Korakolo	Butana, Arfa Gadamk and Fetarita
	Sesame	Gabroak, Heraihery, Balwa and Dlemait	Heraihery, ElObeid-1 and Bromo
	Pearl millet	Dembi	Dembi, Ashana and Beiodah
	Ground nut	Barberton and Elahi	Swoderi and Ghebeish
	Roselle	Abo Shinikle Elaswad(Black), Abo Nagma, Elbetairah, Fetahya and Marat Elmughtareb	Abo Shinikle Elaswad(Black), Abo Nagma, Elbetairah, Fetahya and Marat Elmughtareb
	Okra	Um Kreishat	Um Kreshat, Karari and Elhindia
	Cow pea	Alfagur Taar and Ein Elghazal	Alfagur Taar and Ein Elghazal
	Water melon	Baladi	Baladi
	Snake cucumber	N/A	N/A
Eledade	Sorghum	Zinary	Zinary
	Sesame	Gabali Elaswad(Black), Gabali Abeid (White) and Heraihery	Gabroak, Heraihery and Bromo
	Pearl millet	Dembi, Heraihery, Ugandi and Kanu	Heraihery
	Ground nut	Abo talata(three seeds) and Barberton	Barberton
	Roselle	Fetahya and Marat Elmughtareb	Fetahya and Marat Elmughtareb
	Okra	Um Kreishat	Um Kreishat
	Cow pea	El Baff and Ein Elghazal	El Baff and Ein Elghazal
	Water melon	Baladi(Sefingah) and Abddagal	Baladi (Sefingah) and Abddagal
	Snake cucumber	-	-
Fareeg Elbagar	Sorghum	Sedairy and Naggad	Yarwasha, Arfa Gadamk and Butana
	Sesame	Heraihery, Gabroak and Balwa	Bromo
	Pearl millet	Dembi and Heraihery	Dembi, Heraihery and Ashana
	Ground nut	Baladi	Swoderi and Ghebeish
	Roselle	Um Shinikle	Um Shinikle
	Okra	Um Kreishat	Um Kreishat
	Cow pea	Garn alkabesh, El Baff, Alfagur Taar and Ein Elghazal	El Baff and Ein Elghazal
	Water melon	Baladi(Sefingah) and Abddagal	Baladi(Sefingah) and Abddagal
	Snake cucumber	-	-
Elddago	Sorghum	Fetarita, Zinary, Arfa Gadamk and Butana, Gadam alhamam	Arfa Gadamk and Butana, Gadam alhamam
	Sesame	White type sesame, Absandoug, Red-Sesame, Heraihery, Gabroak and Balwa	Kenana, Absandoug, Heraihery, Gabroak and Balw
	Pearl millet	Dembi	Dembi
	Ground nut	Swoderi and Swoderi	Swoderi and Swoderi
	Roselle	Kaab Elarose, Marat Elmughtareb and Elrahad (white)	Kaab Elarose, Marat Elmughtareb and Elrahad (white)
	Okra	Um Kreshat and Karari	Um Kreshat and Karari
	Cow pea	Alfagur Taar, El Baff and Elsekhaila	Alfagur Taar, El Baff and Elsekhaila
	Water melon	Baladi	Baladi
	Snake cucumber	Addrdago	Addrdago
Wad Akkam	Sorghum	Alzol Meno	Arfa Gadamk
	Sesame	Heraihery, Gabali and Balwa	Heraihery, Gabali and Balwa
	Pearl millet	Yellow seeded	Yellow seeded
	Ground nut	-	-

Table 4. Contd.

	Roselle	Abshalaleif(red)	Abshalaleif(red)
	Okra	Um Kreishat	Um Kreishat and Khartoumy
	Cow pea	-	-
	Water melon	Baladi	Baladi
	Snake cucumber	-	-
Sawarda	Sorghum	Zinary, Naggad, Gadam Elhamam and Yarwasha	Zinary, Naggad, Gadam Elhamam and Yarwasha
	Sesame	Heraihery and Absandoug	Heraihery and Absandoug
	Pearl millet	Heraihery	Heraihery
	Ground nut	-	--
	Roselle	White and Red Types	White and Red Types
	Okra	-	--
	Cow pea	Garn alkabesh and Alfagur Taar	Garn alkabesh and Alfagur Taar
	Water melon	Baladi (local white types)	Baladi(local white types)
	Snake cucumber	-	--

between 180 and 2250 kg/ha in sorghum, 90 to 810 in pearl millet, 240 to 711 in sesame, 200 to 800 in roselle, 1500 to 2600 in ground nut, and 900 to 1200 in okra.

Farmer concept and indigeous knowledge

The farmer concept of agriculture is food and life. No big difference in farmer concept was observed. The planting of seeds started according to stars appearance, or certain period of year they name it 'Einah' the year is divided to 'Einahs' which each having eleven days. The results of indigenous knowledge showed adaptation to drought farmers through experience developed strategies against the vagaries of climate (drought), and severe outbreak of pests and diseases. One of these strategies is to overstore popular and other late and medium varieties.

In case of loss in one season, there will be enough reserves from good seasons to be carried for the next planting seasons. Drought lessons learnt farmers to grow many crops and a mixture of local types in their fields rather than a single strain this might also include cultivars with different days to maturity. Knowledge about labour forcing management: traditional farmers in North Kordofan generally plant pearl millet in dry sowing before rainy season in sandy soil to save time and after then plant varietal mixtures of the same crop mixtures with different maturity durations, morphology and any other quality standards.

The idea behind this practises are farm labour management from sowing to harvest their crops according to crop maturity. These practices enabling them to allocate their limited labour force in performing cultural practices as weeding, thinning and post harvest process. Farmers for some extent succeeded stored cowpea avoid severe bruchids infestation of cowpea by developing practices after harvest, they give a sun dry to harvested pods or threshed seeds, by putting them above the house roofs and "shelters". The seeds are then stored in sugar sacs or empty hot pepper sacs. The seeds are sometimes stored in pits covered by layers of leaves or branches of "Neam", "Rehan" and "Kursan".

DISCUSSION

Sheikan and Alrahad localities

The farming systems in North Kordofan state are based on traditional agriculture. The major crops grown are sorghum, millet (food crops), and sesame, Roselle and groundnut (cash crops). Other crops grown are cowpea, okra, watermelon and snake cucumber. The agricultural system relied on using farmer varieties purposely because it meets farmer desires, adapted to the harsh unfavourable environment and also is been used to manage farm labour forces. The agricultural activity achieved by men and women in collective action in both localities. As a result of climate change some varieties were disappeared from the field as maize and bambara ground nut.

Climate change scenarios indicated that water shortages and shortening of the effective growing season are increasingly likely in Sub-Saharan Africa, increasing the need for short-duration cereals such as sorghum (Abdalla and Gamar, 2011). The result witnessed the reality and impact of climate change in changing of the field crop structure. In the past time greater Kordofan where North Kordofan is part of it is famous in growing

Table 5. The cultivars identified by farmers, Elrahad locality.

Village	Crops	Past grown cultivars	Present grown cultivars
Um Elsheikh	Sorghum	Alzol Meno, Zinary, Naggad, Arfa Gadamk	Alzol Meno, Zinary, Naggad, Arfa Gadamk
	Sesame	Heraihery and Absandoug, Baladi (local white Type)	Heraihery and Absandoug, Baladi (local white Type)
	Pearl millet	Heraihery and Baladi Guhani (local red types, long panicle, late maturing)	Baladi Guhani (local red types, long panicle, late maturing)
	Ground nut	Baladi(Elatgareb) and Ghebeish	Baladi(commercial) and Ghebeish
	Roselle	Wad Elkebeir, Fetahya, Elmahadi Naim(Abo Nagma), Elfainger, Wad Abkeir, Ganghawia(black and tall)	Wad Elkebeir, Fetahya, Elmahadi Naim(Abo Nagma), Elfainger, Wad Abbkeir, Ganghawia(black and tall)
	Okra	Um Kreishat, Kuraa Algidada, Karari and Gelaisah	Um Kreishat, Karari and Gelaisah
	Cow pea	-	-
	Water melon	-	-
	Snake cucumber	Baladi(local)	Baladi(local)
Gaghror	Sorghum	Zinary, Gadam Elteital, Arfa Gadamk and Wad Elfehal	Wad Ahmed and Butana
	Sesame	Wad Elmurdi, Heraihery and Gabroak	Bromo and Gabali
	Pearl millet	Red-Baladi,	Ashana
	Ground nut	Swoderi	Swoderi
	Roselle	Angola, Argud Faaig(easy peeling), KHashmi Gadrah Alaih(Difficult peeling) and Um Buggeh	Angola, Argud Faaig(easy peeling), KHashmi Gadrah Alaih(Difficult peeling) and Um Buggeh
	Okra	Um Kreishat, Karari and Gelaisah	Um Kreishat and Gelaisah
	Cow pea	Alfagur Taar and El Baff	Alfagur Taar, El Baff and Ein Elghazal
	Water melon	-	-
	Snake cucumber	-	-
Um Habila	Sorghum	Zinary	Butana and Arfa Gadamk
	Sesame	Heraihery	Elobied-1, Kenana-1, Kenana-2, White seeded, Abo Naama and Absandoug
	Pearl millet	Dembi and Heraihery (Yeloow type)	Ashana
	Ground nut	Um Bitaih, Barberton, Ghebeish and Swoderi	Barberton and Ghebeish and Swoderi
	Roselle	Fetahya, Sabrein, Marat Elmughtareb, Saif Alabour, Gaddoum Mahbob, Um Geboan, Um Shibek, Um Buggeh, Um Shera, Um Kweidaya	Fetahya, Sabrein, Marat Elmughtareb, Saif Alabour, Gaddoum Mahbob, Um Geboan, Um Shibek, Um Buggeh, Um Shera, Um Kweidaya
	Okra	Um Kreishat	Um Kreishat, Karari and Kuraa alaghurab
	Cow pea	El Baff, Gushaliah	El Baff, Gushaliah and Ein Elghazal
	Water melon	Sifingah, Leibi, Um Segheiroan, Um Hemeiroan	Sifingah, Leibi, Um Segheiroan, Um Hemeiroan and Crimson sweet
	Snake cucumber	-	-
Warshal	Sorghum	Arfa Gadamk, Korakolo and Tabat	Arfa Gadamk and Tabat
	Sesame	Heraihery, Abo Naama	Elobied-1, White seeded, Abo Naama and Absandoug
	Pearl millet	Heraihery (Yellow)	Heraihery (Yellow) and Ashana
	Ground nut	Abo talata(three seed in the pod), Barberton and Swoderi	Abo talata(three seed in the pod), Barberton and Swoderi
	Roselle	Fetahya, Sabrein, Marat Elmughtareb and Abo shenkal	Fetahya, Sabrein, Marat Elmughtareb and Abo shenkal

Table 5. Contd.

Okra	Um Kreishat, Sara(wild) and Kentaisha	Um Kreishat, Sara(wild), Kentaisha and Karari
Cow pea	Local white seed, Alfagur Taar, Garn alkabesh	White seed, Alfagur Taar, Garn alkabesh and Ein Elghazal
Water melon	local	local
Snake cucumber	-	-

pearl millet but due to different production constrains and deterioration of farmer varieties lead to decreasing in the area covered with the crop and currently been replaced with sorghum. The current result is inconsistency with history of the area which stated in Kordofan region, most of the pearl millet production observed in the extensive sandy soils "Goz!' occupying the northern parts of the region, these are marginal areas with less than 400 mm rainfall. The reference continued in these areas, pearl millet is the most extensively grown crop, and therefore, a millet-based farming system prevails (Abu Elgasim, 1992). However, the cultivation of the crop extends further south into the clay soils where rainfall goes up to 700 mm. in Sheikan locality the community showed more importance for food crops when compared to cash and crops, but Elrahad locality showed same weight of food and cash crops.

This result is corresponding with the results of the dry /wet seasons which showed 50:50 in Elrahad and 43:57 Sheikan localities, which showed Elrahad with equal chances of crop success and failure has relatively high risk comparing to Sheikan. This fact led Elrahad farmers practising the indigenous knowledge of planting different crops to tackle the moisture problem. The results showed high biodiversity of roselle in Elrahad locality.

Productivity of field crops and informal seed system

The productivity of food crops described as fluctuated comparing to national and international productivity. In north Kordofan sorghum yield showed the rate between 180 and 2250 kg/ha. National sorghum productivity is rated between 585 and 778 kg/ha (Elasha and Ibrahim, 2007). North Kordofan showed high potential in producing sorghum grains when farmers selecting the suitable varieties as appeared in Faris village the productivity is above the national maximum level.

Pearl millet in the target areas showed the rate 90 to 810 kg/ha. When the national level of grain yield annually obtained is very low, the average being below 200 kg/ha (Abu Elgasim, 1997). Also the covered area showed high potential for producing pearl millet. Pearl millet for western Sudan is more than a crop, it is named “elaish” an Arabic word meaning “living” for its high use in human food as the grain is consumed as porridge called “aseeda” or in form of a thin pancake called “kisra”, and the stalks are used as feed for animals or building material (Yasir and Adam, 2011). Sesame productivity showed the rate 240 to 711 kg/ha. The national average is 150 kg/ha and the international average is 440 kg/ha (FAO statistics, 2006). The productivity showed higher than the national and comparable to international average.

The decrease of productivity in national level might come due to post harvest operations, insect pests and handlings. The ground nut showed the rate between 1500 to 2600 kg/ha in the examined areas. Groundnut is grown on nearly 23.95 million ha worldwide with the total production of 36.45 million tons and an average yield of 1520 kg/ha in 2009 (FAOSTAT, 2011). The covered area showed potential in producing food and oil crops some of the crop productivity which exceeded the international average. Participatory of rural communities with NGO’S or government working in rural development showed only the level of functional participation which means the full process of participation is not completed. In which the farmers stopped seeking for the new developed varieties and technologies when the projects ended. The highest level of participation is self mobilization according to Pretty et al. (1995) by then learning and involvement in decision making empowerment.

Conclusions

In North Kordofan the fluctuation of rains considered as major factor affecting field crop structure. Most of the planted varieties are farmer varieties that revealed agricultural system is need for the new varieties as well as agricultural technologies. The production is constrained by drought, striga and lack of post harvest technologies. The informal seed system play major role in seed dissemination.

Conflict of Interests

The authors have not declared any conflict of interests.

ACKOWLEDGMENTS

Authors are grateful to International Fund for Agricultural

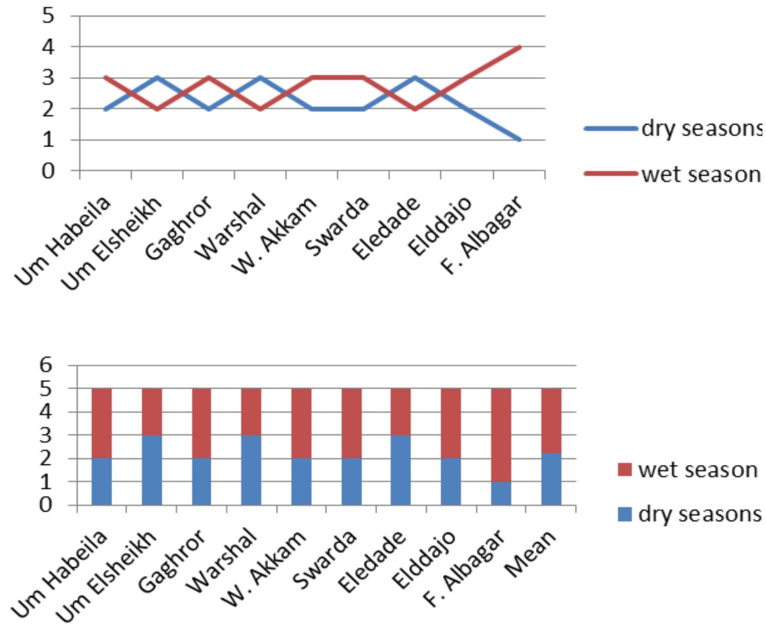

Figure 3. Combine wet and dry seasons in the last five rainy seasons in ten villages of Sheikan and Elarahad localities of North Kordofan state.

Development (IFAD)/Seed Development project in Sudan for the financial support. Also many thanks go to extension agents, state ministry of agriculture, North Kordofan.

REFERENCES

Abdalla HM, Gamar YA (2011). Climate change: Selection of sorghum genotype with wide adaptation, AG-17, for rain-fed areas of Sudan. Int. J. Agri. Sci. 1(3):144-555.
Abuelgasim EH (1992). Pearl millet genetic resources in the Sudan. Workshop on Crop Genetic Resources in the Sudan. Agricultural Research Corporation, Wad Medani, Sudan.
Abulgasim EH (1997) Pearl millet Research and production in the Sudan. A paper presented in the scientific seminar of the Federal Ministry of Agriculture and Forests. Khartoum, Sudan. November 29:9 (in Arabic).
Central Bureau of Statistics. (2010). Sudan in Figures. Khartoum, Sudan.
De Boef WS, Thijssen MH (2007). Participatory tools working with crops, varieties and seeds. A guide for professionals applying participatory approaches in agrobiodiversity management, crop improvement and seed sector development. Wageningen, Wageningen International, P 83.
Elasha AE, Ibrahim NE (2007). Cultivation of sorghum plants in irrigated and rain-fed sector of Sudan. Leaflet for Sudanese farmers (in Arabic).
FAO (2013). Production Yearbook. FAO, Rome, Italy.
FAO (2011). Production Yearbook. FAO, Rome, Italy.
FAO (2006). Production Yearbook. FAO, Rome, Italy.
Mohamed A H, Gamar YA, Osama ME, Mohamed HE, Assar AH (2011). Performance of selected sorghum genotypes under rain-fed areas of Sudan. Int. J. Life Sci. 5:2119-2127.
Kidd R (1985). Theatre for development: Diary of a Zimbabwe Workshop. New Theatre Q. I, (2 May).
Pretty JN (1995). Participatory learning for sustainable agriculture. World Development 23:1247-1263.
Rahman MA, Fals-Borda O (1991). A Self-review of PA R. In Action and Knowledge: Breaking the Monopoly with Participatory Action Research. Intermediate Technology Publications, London.
Siddig K (2009). Macroeconomy and Agriculture in Sudan: Analysis of Trade Policies, External Shocks, and Economic Bans in a Computable General Equilibrium Approach. A PhD thesis, Giessen University, Germany.
Woelk GB (1992). Cultural and structural influences in the creation of and participation in community health programme. Soc. Sci. Med. 35:419.
Yasir AG. Adam MA (2011). A self review in ASARECA pearl millet innovations for improved livelihoods in drought-prone areas of Eastern and Central Africa (ECA) project document.

academicJournals

Vol.8(3), pp. 29-38, March 2016
DOI: 10.5897/JAERD2014.0705
Articles Number: 4E7156A56998
ISSN 2141-2170

http://www.academicjournals.org/JAERD

Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Analysis of honey production systems in three agro-ecologies of Benishangul-Gumuz, Western Ethiopia

Alemayehu Abebe[1]*, Yilma Tadesse[2], Yohannes Equar[3], Mulisa Faji[1] and Habtamu Alebachew[1]

[1]Assosa Agricultural Research Center, P. O. Box 265, Assosa, Ethiopia.
[2]King Saud University, Riyadh, Saudi Arabia.
[3]Holleta Agricultural Research Ceneter, Ethiopia.

Received 22 May, 2015; Accepted 23 July, 2015

The study was conducted in three districts of Benishangulgumuz Regional State, Western Ethiopia, to characterize honey production systems, identify major constraints limiting honey production and suggest the required development intervention options for future development. Purposive sampling technique was used to select the districts that represent the three agro-ecologies of the region. A total of 120 beekeeping households were selected and individually interviewed in their respective farms using pre-tested semi-structured questionnaire. Stratified sampling technique was used to select the households. Data was analyzed using descriptive statistics, chi-square test and one-way ANOVA of SPSS software. The results revealed that the number of bee colonies per household were not different across the districts. Honey yield from traditional and transitional hives varied across the districts, but not from modern hive. Beekeeping sector of the areas is constrained by high cost and limited availability of modern beekeeping equipments and accessories, inferior quality of honey, honeybee enemies, inadequate research and extension services, and shortage of skilled human power. Thus, to benefit beekeepers from the sector, alleviating the prevailing constraints and exploiting the available opportunities is important.

Key words: Honey production, Benishangulgumuz, reproductive swarming, migration, beekeeping constraints.

INTRODUCTION

Ethiopia has a longer tradition of beekeeping than any country in the world even though the sector is still undeveloped sector of agriculture (Melaku et al., 2008a). The country is one of the major honey and beeswax producers in the world; the largest honey producer in Africa and the10th largest producer in the world (Girma, 1998; Kerealem et al., 2009). Ethiopia possesses natural resources that are favourable to beekeeping activities. However, the contribution of the sector to the national economy is very low due to traditional honey production and wax extraction practices of beekeepers.

In many regions of the country, beekeeping generates

*Corresponding author. E-mail: alabe_2008@yahoo.com.

income for resource-poor farmers including women, youth and the unemployed sectors of the country (Melaku et al., 2008b). The sector also suits to areas where other agricultural activities are limited like harsh agro-systems where crop production is marginal and livestock cannot exist. Moreover, beekeeping stabilizes and protects fragile environments since it is environmentally sustainable activity and can be integrated with other agricultural practices. Honey bees are good pollinating agents thereby increasing crop productivity and conserving plant biodiversity (Teferi et al., 2011).

Assosa, Homosha and Mao-Komo districts of Benisangulgumz regional state are believed to be potential areas for beekeeping development as they have good climatic conditions and diversified bee flora. But, there is no compiled and reliable information on honey production systems in the areas so far. The sector at country level is constrained by lack of knowledge, shortage of trained man power, shortage of beekeeping equipments, pests and predators, and inadequate research and extension services to support beekeeping development programmes (SOS-sahel-Ethiopia, 2006). Benishangul gumuz regional state cannot be exceptional from these constraints.

But, for any developmental strategies that intervene prevailing constraints, a full characterization and understanding of the production systems is very essential. Therefore, this study was conducted to characterize honey production systems, identify the major constraints limiting honey production and suggest the required development interventions for future improvement.

MATERIALS AND METHODS

Study area

This study was conducted in three districts of Benishangulgumuz regional state, namely Assosa, Homosha and Maokomo. The three districts were selected to represent the three agro-ecologies of the regional state. Maokomo represents highland, Assosa mid-altitude and Homosha represents lowland. Assosa town is located 670 km west of Addis Ababa. Maokomo is located about 105 km south of Assosa town and Homosha is located about 30 km west of Assosa town.

Benishangulgumuz regional state is located between geographical coordinates: 9°30'N-11°39'N latitude and 34°20' E to 36°30' E longitude with altitude ranging from 1272 to 1573 m above sea level. Mean annual rainfall and temperature in the region range between 700 to 1450 mm and 21 to 35°C, respectively (AMS, 2008). Major crops grown in the areas are sorghum, maize, finger millet, soya bean and ground nut. Livestock species commonly kept are goats, cattle, chicken and donkeys in order of importance (AsARC, 2006).

Sampling method

The three districts were selected purposively based on their agro-ecology. Then stratified random sampling technique was used to select peasant associations (PAs) and the sample respondents. A total of 120 beekeepers were randomly selected for questionnaire interview and farm visit from the three districts.

Sources and methods of data collection

Pre-tested semi-structured questionnaire was used to interview the selected beekeepers. The interview was held in their respective farms using a local language. Then, group discussions with key informants and local administrators were held in each PA. The questionnaire covered a large range of variables which include demographic characteristics, resource holdings, beekeeping management practices, honey marketing and constraints of beekeeping.

Focus group discussions were primarily on ranking of constraints, diseases, pests and predators of beekeeping in the areas. Secondary data such as number of bee colonies, amount and type of bee hives, honey marketed per year were collected from agricultural offices of the districts.

Data analysis

Data collected was managed in such a way that the qualitative as well as quantitative variables can be analyzed. Data were entered into SPSS (version_20) and coded for analysis. Descriptive, one-way ANOVA and chi-square test were used for data analysis. Districts representing the three agro-ecologies (highland, mid-altitude and lowland) were used as fixed factors for most of dependent variables in one-way ANOVA model. The model used for the analysis was:

$$Yi = \mu + Di + \varepsilon i$$

Where, Y_i is dependent variable, μ is overall mean; D_i is the fixed effect of districts; i = Assosa, Homosha and Maokomo; ε_i is a random error. Chi-square test was used to determine differences in percent frequencies of nominal data. For all analysis, the level of significance was set at 5%.

RESULTS

Demographic characteristics

The mean age of household head and family size of the sample households are presented in Table 1. Age of household heads was not significantly (P>0.05) different among the districts. However, family size of Assosa was significantly (P<0.05) less than family size of Homosha and Maokomo districts. The sample respondents from Assosa and Maokomo districts were better educated than that of Homosha (Figure 1). About 95% of the sample households were male headed and majority of them (88.3%) were married.

Land and livestock holdings

Land and livestock holdings of the sample respondents are shown in Table 2. The sample respondents of Assosa had significantly (P<0.05) larger land size than that of Maokomo. Number of cattle, sheep, goat and equines kept per household were significantly (P<0.001) different

Table 1. Age and family size of the sample households.

Variable	District						P-value	Sign.
	Assoa; N=40		Homosha; N=40		Mokomo; N=40			
	Mean	SEM	Mean	SEM	Mean	SEM		
Age	37.8	2.19	39.4	1.70	36.4	1.23	0.713	ns
Male family size	2.4[b]	0.17	3.1[ab]	0.34	3.7[a]	0.28	5.338	**
Female family size	3.3	0.23	4.0	0.34	4.0	0.29	1.544	ns
Total family size	5.6[b]	0.32	7.0[ab]	0.62	7.6[a]	0.47	3.903	*

NsNon-significant, *P<0.05, **P<0.01, ***P<0.001; means with the same letters across rows are not different at 0.05 level.

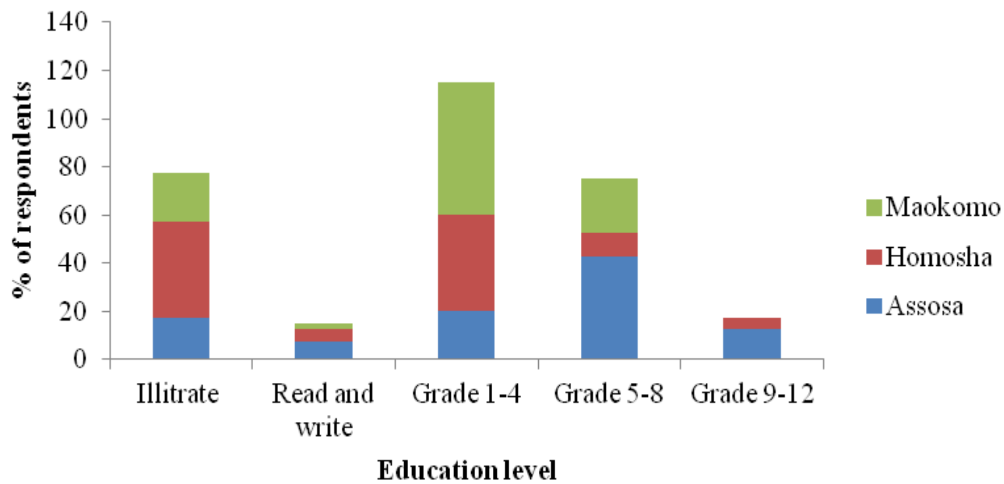

Figure 1. Education status of sample respondents.

Table 2. Land and livestock holdings of the sample respondents.

Variable	District						P-value	Sign.
	Assoa (N=40)		Homosha (N=40)		Mokomo (N=40)			
	Mean	SEM	Mean	SEM	Mean	SEM		
Total land (ha)	2.1[a]	0.23	1.7[ab]	0.17	1.45[b]	0.13	3.389	*
Grazing land (ha)	0.5[a]	0.12	0.1[b]	0.04	0.1[b]	0.05	6.705	**
Cultivated land (ha)	1.6	0.90	1.5	0.17	1.4	0.10	1.038	ns
Apiary site (ha)	0.03	0.02	0.03	0.02	0.0	0.00	0.981	ns
Cattle	2.3[b]	0.32	0.9[c]	0.32	3.5[a]	0.35	14.323	***
Sheep	0.7[a]	0.16	0.1[b]	0.07	0.9[a]	0.19	7.244	***
Goat	3.6[b]	0.54	5.2[a]	0.69	0.6[c]	0.29	17.437	***
Equines	1.0[a]	0.12	0.4[b]	0.12	0.5[b]	0.12	5.593	***
Chicken	8.4[a]	0.99	10.3[a]	1.74	3.9[b]	0.71	7.318	**
TLU	2.9[a]	0.25	1.6[b]	0.25	2.7[a]	0.34	6.217	**

NsNon-significant, *P<0.05, **P<0.01, ***P<0.001; means with the same letters across rows are not different at 0.05 level.

among the districts. Larger number of cattle and sheep per household were kept in Maokomo district than others. The sample respondents in Homosha used to keep more number of goats compared to the rest districts. Whereas, the sample respondents in Assosa possessed more number of equines than the sample respondents in

Table 3. Number of colonies owned and mean honey yield estimates by the sample respondents in the study areas.

Variable	District						P-value	Sign.
	Assoa (N=40)		Homosha (N=40)		Mokomo (N=40)			
	Mean	SEM	Mean	SEM	Mean	SEM		
Bee colony (total)	17.1	2.99	15.0	2.79	18.4	1.92	0.436	ns
Bee colony in traditional hive	10.2[b]	2.22	8.9[b]	1.72	17.1[a]	1.95	5.012	**
Bee colony in transitional hive	0.4	0.22	4.5	2.39	0.03	0.03	2.678	ns
Bee colony in modern hive	6.9[a]	1.91	1.9[b]	0.34	0.6[b]	0.11	9.866	***
Honey yield/hive/year (kg)								
Traditional	3.3[b]	0.41	5.8[a]	0.47	6.5[a]	0.55	9.680	***
Transitional	6.5	0.87	11.3	0.82	-	-	12.939	***
Modern	14.3	0.96	15.7	1.28	14.7	1.71	0.398	ns

[Ns]Non-significant, *P<0.05, **P<0.01, ***P<0.001; means with the same letters across rows are not different at 0.05 level.

Homosha and Maokomo. The assessment also showed that more number of chickens was kept per household in Assosa and Homosha than Maokomo.

Hive types, colony distribution and honey yield

There were 43201 traditional, 273 intermediate and 2079 improved box hives in the study areas (BOARD, 2011). The traditional hives are made of bamboo and grass. Most beekeepers hang their traditional hives upon trees in the forest or homestead until honey harvesting season. Transitional hives are not widely used in study areas.

The number of colonies owned per household were not significantly (P>0.05) different across the districts. However, the sample households in Maokomo had significantly (P<0.01) larger number of bee colonies in traditional hive compared to the sample households in Assosa and Homosha. Contrary to this, the number of bee colonies in modern hives were significantly (P<0.001) larger in Assosa than Homosha and Maokomo (Table 3). Estimates of honey yield varied across the districts as well as hive types. Modern hive yielded more honey followed by transitional hive. Honey yield from traditional hive per year was significantly (P<0.001) higher in Maokomo than Assosa and Homosha. Honey yield from transitional hive was significantly (P<0.01) higher in Homosha than Assosa. The sample households from Maokomo did not use traditional hive at all. Modern hive yielded comparable amount of honey across the districts (Table 3).

Honeybee management practices

In the study areas, colony is usually obtained by trapping swarm which is done by hanging traditional hives upon trees. Colonies are trapped twice a year, first from September to November and then from February to March. However, the sample respondents reported that honeybee population is declining over the years in the study areas. The sample respondents indicated that they smoke the traditional hives on average for 1.6 h with cow dung, wax, or bark and leaf of some trees together or separately to attract swarm.

Traditional hives are hanged on trees either at homestead or forest whereas modern and transitional hives are usually put at backyard under shade. Traditional hives were inspected externally by the sample respondents and internal inspection was unknown unless it is for honey collection. From 83 sample respondents having modern box hive, it was indicated that 73.5% of them make an external inspection on daily basis whereas the rest inspect their box hives externally once a week. Internal inspection was made only at a time of honey harvest. During honey collection from traditional hive, the sample respondents indicated that they remove all combs destroying a colony.

Honeybee swarming and migration

The sample respondents mentioned that reproductive swarming is a frequent phenomenon in the study areas. Majority of the sample households did not use either to prevent or control a reproductive swarming. But, some households had prevention and control methods of reproductive swarming as indicated in Table 4. The prevention and control methods varied significantly (P<0.001) across the study districts. Colony migration was also mentioned as one of the top problems in the study areas. The major reasons mentioned for migration were lack of feed, pests and predators, human interference especially at a time of honey collection, and wind in order of importance.

Provision of supplementary feeds, water and shade

More than half of the sample respondents used to provide supplementary feeds and water to their colonies in modern and transitional hives in dearth periods (Figure

Table 4. Prevention and control practices of reproductive swarming and migration by the sample households.

Variable	District			X^2
	Assosa (N=40) %	Homosha (N=40)%	Maokomo (N=40) %	
Do you prevent reproductive swarming? (Yes)	62.5	40	12.5	23.191***
Do you control reproductive swarming? (Yes)	20.0	45.0	12.5	17.347**
Prevention methods for reproductive swarming				
No prevention	40	60	100	
Removing supersidures	17.5	25.0	0.0	
Supering/providing more space	12.5	0.0	0.0	42.650***
Use of queen excluder	17.5	10.0	0.0	
Removing supersidures and use of queen excluder	12.5	5	0.0	
Control methods for reproductive swarming				
No control	80	55	87.5	
Killing queen of swarm	12.5	45	0.0	41.645***
Transferring swarm to another hive	7.5	0.0	0.0	
Putting traditional hive around	0.0	0.0	12.5	

*, ** and *** are significant at P=0.05, 0.01 and 0.001, respectively.

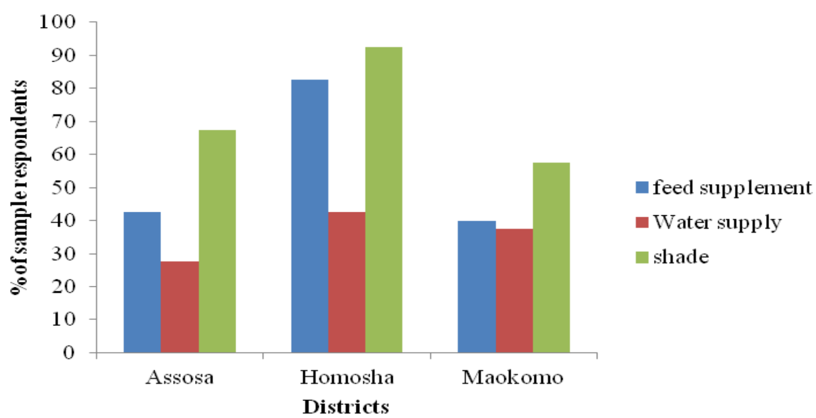

Figure 2. Percentage of the sample respondents in the study districts used to supplement feed in dearth periods, supply water and use shade for colonies.

2). Commonly used feeds reported were flour of cereals and sugar. However, colonies in traditional hives are not given a supplementary feeds and water in the study areas. Concerning shade for hives, the sample respondents used thatched roof and trees for modern and transitional hives. Traditional hives were hanged upon trees primarily in the forests and collected after honey harvest (Figures 3 and 4)

Honey management practices

February, November, and December are the major honey harvesting periods in Assosa, Homosha and Maokomo districts, respectively. But, honey management practices are not different across the districts. Beekeepers in the study areas collect honey by removing all the combs from traditional hives thereby discarding their colonies and starting with new colonies each year. Honey collected from traditional and transitional hives is usually inferior in quality compared to honey collected from modern hives. The sample respondents having modern and transitional hives use protective clothes and smoke during honey collection. Beekeepers with only traditional hives do not use protective clothes, but some reported that they smear honey on their hands and work naked to protect themselves.

Honey is collected when beekeepers expect it is ready for harvesting without checking its ripeness. Thus, beekeepers are often not aware of differences in honey

Figure 3. Traditional beehives hanged upon the tree at Maokomo.

Figure 4. Traditional hives collected by beekeeper after honey harvest at Assosa.

quality due to water content. Beekeepers in the study areas detect honey harvesting time by observing bees accumulated on the entrance of hive, movement of bees, season, honey smell and sound of bees.

About 90% of interviewed beekeepers used to store honey from 1 month to 1 year for profit maximization (88%), for medicinal value, as a saving account and for continuous consumption. Few respondents indicated that storing honey for certain period increases its weight and this benefits them. Various types of plastic containers and sacs which are available in local markets are used for honey storage. Few beekeepers use plastic cups to store pure honey from modern hives as they are lacking in the local markets as mentioned by most of the sample respondents.

Honey marketing

Majority (95%) of the sample respondents in the study areas produce honey primarily for market (Figure 5). The average price of crude honey in local markets per kg was

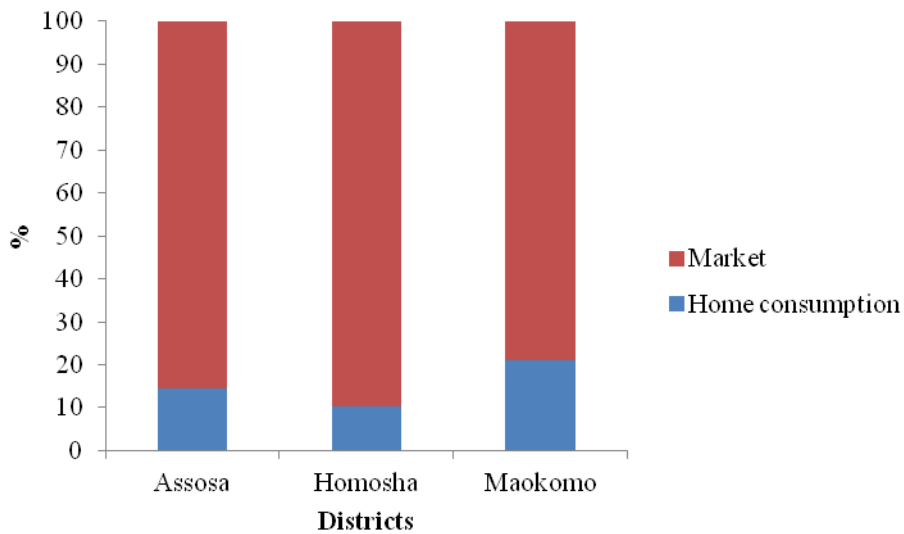

Figure 5. Utilization of honey produced by the sample respondents in the study districts.

$1 in Assosa, $1.2 in Homosha and $1.3 in Maokomo. Whereas, the average price of extracted honey in local markets was $2.2 in Assosa, $1.9 in Homosha and $2.4 in Maokomo per kg. The price of traditional hive made of locally available materials was $0.5. The sample households put up for sale on average 58.49 kg of extracted and 80.69 kg of crude honey each year and had revenue of $139 per household per year.

Honey bee flora

Based on findings from the sample respondents and field observations, there were diversified types of bee flora in the study areas. Many of cultivated crops in the areas serve as pollen, nectar, or both pollen and nectar sources. Mainly shrubs, cultivated crops, forbs, herbs, weeds and some woody plants were used as a main bee forages for the first honey flow season (October - December) whereas woody plants were the main source of pollen and nectar for the second honey flow season (February to May). For this study, honeybee flora of the study areas was not investigated in detail. The sample respondents indicated that the availability of bee forages is seasonal and hence, feed shortage occurs in some months of a year, especially in dry period. It was also indicated that the distribution of bee forages in the study areas is declining over time due to deforestation and expansion of cultivated lands.

Pests and predators

Economically important pests and predators of the study areas are indicated in Table 5. The rankings were made based on focal group discussions in each districts. This study showed that ants, honey badger, wax moth, small hive beetle and spider were frequently occurring pests and predators of the three districts. Whereas, bee-eater birds, head hawks, bee lice, and premantides were found to occur rarely. Beekeepers in the study areas have their own mechanisms to prevent honeybee pests and predators. For instance, to protect ant, they put ash and burned fuel around hive stands; to prevent honey badger, they fix smooth iron sheet on trees that traditional hives are hanged, or put fences around the trees, and select trees that are not conducive for honey badger to climb. Bee diseases of the study districts were not covered in this study since it needs diagnostic survey and the sample respondents had limited knowledge to differentiate diseases. However, some of the sample respondents indicated that sometimes they face honeybee deaths in and around hives.

Constraints

The major constraints of beekeeping in the study areas mentioned by the sample respondents and key informants include:

1. High cost and limited availability of modern beekeeping equipments and accessories: These include box hive, casting mould, frame wires, honey extractor, and containers. The sample respondents reported that modern hive constructed by some private companies and cooperatives in the study areas are of poor quality, that is with wrong dimensions and made of poor quality timber. As a result, migration rate of honey bees in modern hive is very high in the areas.
2. Inferior quality of honey due to poor management: Majority of honey in the study areas comes from

Table 5. Rank of economically important pests and predators in the study areas.

Pest/predator	Hive type (Rank)		
	Traditional	Transitional	Modern
Ant	6	1	1
Wax moth	3	3	2
Honey badger	1	5	5
Spider	4	2	3
Birds	2	6	6
Mice	8	6	7
Lizard	7	6	7
Small hive beetle	5	4	4
Wasp	9	6	7
Snakes	9	6	7
Head hawks	10	6	7

traditional hives and consequently, this honey contains beeswax debris and other non honey impurities. Due to limited knowledge, there is mishandling of honey after harvest which includes use of inappropriate storage materials and wrong storage places.

3. Theft, pests and predators: The sample respondents of this study indicated that theft (human pest) is one of major problems in the study areas. The major pests and predators reported include ants, wax moth, honey badger, spider, honey hunter birds, mice, lizards, small and large hive beetles, honeybee lice, wasps, snakes and head hawks.

4. Lack of honey processors: There were neither large-scale nor small-scale honey processors in the study areas. This in turn, leads to poor quality honey consequently with low price for the producers.

5. Inadequate research and extension services: The districts where this study has been conducted are one of the remotest areas of the country. Thus, the areas were lacking adequate research and extension services in areas of modern beekeeping. This was manifested in this study that majority of the sample respondents had only traditional hives and the way they handle honey bees is backward.

6. Shortage of skilled human power: Benishangulgumuz region is one of emerging regions of the country. As a result, it is constrained by trained human power to assist beekeepers in the areas of modern beekeeping. The sample respondents and key informants also noted that they do not get sufficient technical assistances in order to improve their current way of honey production.

Opportunities

Based on group discussion and personal observations, the major opportunities to improve and expand the beekeeping sector in the study areas are:

1. Availability of honeybee colony in huge amount;
2. Diversified honey bee flora.
3. Tourists as the study areas are in proximity to Ethiopian Grand Electric Dam.
4. Attention given by the government to the sector.
5. Environmental friendliness of the sector.

DISCUSSION

The significantly larger family size in Maokomo and Homosha is likely related with polygamy marriage in the areas. Better education level of household heads in Assosa and Maokomo could be attributed better access to education in the areas. The likely reason behind differences in number of livestock species owned by the sample respondents among the districts is agro-ecological differences. Maokomo is highland and trypanosomiasis free area and thus, it’s more conducive to sheep and cattle. Homosha is lowland and this favors more likely goat production.

The availability of significantly greater number of honeybee colonies in traditional hives in Maokomo district is related with availability of dense forest, and lack of access to transitional and modern box hives. In contrary, the sample respondents in Assosa district possessed significantly greater number of honeybee colonies in modern hives which is related with availability of modern hive production centers in Assosa town.

The average honey yield in the study areas from traditional hive (5.2 kg/colony/year) is comparable to national average (5-8 kg/colony/year); from transitional hive (8.9 kg/colony/year) is less than the national average (20 kg/colony/year) and from modern hive (14.9kg/colony/year) is also less than the national average (30 kg/colony/year) (MOARD, 2007). The lower honey yield in transitional and modern hive could be likely attributed to higher absconding rates of honeybee race of the study areas (*A. mellifera* scutallata) and poor management practices due to skill gaps in modern beekeeping. The sample respondents reported that colonies in transitional and modern hives usually abscond after honey harvest. This might be due to mishandling of colonies during honey harvest which include use of too much smoke and removing all honey combs. The incidence of honeybee enemies could be also a reason for higher absconding rates. Majority of the visited beekeepers do not use partition in transitional hive and queen excluder in modern hive. This leads to lower number of honey frames in the hives subsequently with lower honey yield per hive. Thus, these and similar skill gaps of beekeepers in modern beekeeping should be narrowed with extensive trainings.

This study revealed that the honey bee population in the study areas is in decreasing trend. The likely reasons behind are: deforestation due to increasing human population and agricultural investments, destruction of bee colonies by wild fire, wide use of pesticides for crop farming and mismanagement of colonies during honey harvest especially in traditional hives which include a total burning of colony.

Reproductive swarming has a negative effect on honey production since it decreases the honeybee population in the hive. It occurs either due to low space available for bees in the hive or low egg production performance of queen. In the former case it can be easily prevented by adding supers in modern hive and providing additional space by removing honey combs in traditional and transitional hives prior to colony produces queen cells. Queen cells can be also removed during internal inspection. Majority of beekeepers in the study areas, however, do not put any effort to prevent or control reproductive swarming which seeks due attention by development organizations to create awareness. In fact, it's difficult to prevent and control reproductive swarming in traditional hives hence internal inspection on tall trees is cumbersome for a beekeeper. Similar scenario has also been reported in honey production systems in southwest Ethiopia (Shenkute et al., 2012).

Migration of honeybee colonies occurs in honey harvesting and dearth periods in the study areas. According to the sample respondents, the possible reasons behind could be feed shortages, bee enemies, human interference and wind, which is in line with findings of Chala et al. (2012); Amsalu (2006) and Shenkute et al. (2012).

Honey harvesting system from traditional hives revealed in this study is similar to Kaffa and Sheka zones of south-western Ethiopia where beekeepers damage brood, discard their colonies after honey harvest and always start from new swarm every year (Shenkute et al., 2012). Some beekeepers also mentioned that they burn colonies to protect themselves from bees attack which in turn has negative implication on the colony population of the areas. Majority of beekeepers in the study areas store honey to sell it when the market price is high, but few indicated that honey storage increases its weight. This increase in weight is due to hygroscopic nature of honey and it has negative effect on quality. Some of other quality related effects of honey storage mentioned in the study areas were spoilage of crude honey, crystallization, loss of natural flavour and attacks by rodents and ants. This has an indication that beekeepers in the study areas should be given with appropriate honey storage equipments coupled with the necessary trainings.

Higher market prices of honey in Maokomo and Homosha compared to Assosa could be related with the availability of huge refugee camps in the two districts. Generally, honey price of the areas is lower than some other parts of the country which could be due to absence of honey businesses operating on a larger scale.

Pests and predators cause a serious damage on bee colonies within short period. Economic importance of pests and predators varied with hive types which is mainly associated with the locations where beekeepers put their hives. For instance, ant is the top ranked pest in transitional and modern hives but not in traditional hive. Since the later is hanged on tall trees, ants cannot easily access it.

On the other side, being in the forest and far from residential areas, traditional hives are more exposed to honey badger, bee-eater birds and theft in contrary to transitional and modern hives. The later hive types are often kept at backyard. Some of the major pests and predators identified in this study like ant, wax moth and spider could be prevented by an appropriate apiary management. Similar bee enemies were identified in previous studies in the other parts of the country (Shenkute et al., 2012; Taye and Marco, 2014; Keralem, 2005).

Intervention options

1. Practical based trainings on modern beekeeping is an important step forward to narrow prevailing gaps in areas of honeybee management and honey handling processes;
2. The accuracy of modern box hives produced by private organizations should be monitored and controlled;
3. Beekeepers should be linked with suppliers of modern beekeeping equipments and accessories;
4. Beekeepers should be organized in associations to be benefitted from their products and for easy access to modern beekeeping technologies
4. Beeswax and other bee products should be promoted in order to provide beekeeper with further income.
5. The diversified bee flora of the area should be documented and conserved.
6. Wild fire often used in the study areas should be avoided.

Conclusion

From this study it was realized that the study areas are potential for beekeeping development, but yet little interventions were made to improve the existing very traditional honey production system. Modern bee keeping equipments and their accessories are not easily accessible and unaffordable to the beekeepers. There are huge knowledge and skill gaps among beekeepers on modern bee keeping which needs extensive practical based trainings. The beekeepers are not getting attractive money for their produces and this needs mechanisms to link them with central markets. Yet, the region is not supported with beekeeping researches to generate new technologies pertinent to the area and thus, concerned bodies should work more on establishing and strengthening apiculture research. In general, to be benefitted from the sector, alleviating the prevailing constraints and exploiting the available opportunities is important.

Conflict of Interest

The authors have not declared any conflict of interest.

ACKNOWLEDGMENT

This study was funded by Ethiopian Institute of Agricultural Research. We thank Research Assistants of Livestock Research Process of Assosa Agricultural Research Center for their contribution in data collection and interviewed beekeepers of the areas for their cooperation.

REFERENCES

AMS (2008). Climatic data. Assosa Meteorological Station (AMS), Benishangul Gumuz Regional State of Ethiopia, Assosa.

Amsalu B (2006). Seasonal intensity of flowering and pollen-forage selectivity by honeybees, Apis mellifera bandasii in central highlands of Ethiopia. Proceedings of the 14th annual conference of the Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia pp. 3-10.

AsARC (Assosa Agricultural Research Center) (2006). Results of Farming System Survey Benshangul Gumuz Regional State. Ethiopian Institute of Agricultural Research; Assosa Agricultural Research Center. Assosa. (unpublished).

BOARD (Bureau Agriculture and Rural Development) (2011). Report of Benishangulgumuz Region Agriculture and Rural Development Office, Assosa, Ethiopia (unpublished).

Chala K, Taye T, Kebede D, Tadele T (2012). Opportunities and challenges of honey production in Gomma district of Jimma zone, South-west Ethiopia. J. Agric. Ext. Rural Dev. 4(4):85-91.

Girma D (1998). Non-Wood Forest Production in Ethiopia. Addis Ababa, Ethiopia.http://www.fao.org/DOCREP/003/X6690E/X6690E00.htm date accessed February, 2014

Keralem E (2005). Honey bee production system, opportunities and challenges in Enebse.Sar Midir Woreda (Amhara Region) and Amaro Special Woreda (Southern Nations,Nationalities and peoples Region), Ethiopia. M.Sc. thesis, Alemaya University, P. 133.

Melaku G, Shifa B, Azage T, Negatu A, Lulseged B (2008a). Approaches, methods and processes for innovative apiculture development: Experiences from Ada'a-Liben Woreda, Oromia Regional State, Ethiopia. Improving Productivity and Market Success (IPMS) of Ethiopian Farmers Project Working Paper 8. ILRI (International Livestock Research Institute), Nairobi, Kenya. 48 pp.

Melaku G, Azage T, Shifa B, Negatu A (2008b). Challenges and opportunities for market oriented apiculture development: The case of Ada'a-Liben district, Ethiopia. Conference on International Research on Food Security, Natural Resource Management and Rural development, University of Hohenheim.

MoARD (2007). Livestock Development Master Plan Study. Phase I Report – Data Collection and Analysis, Volume N -Apiculture. Addis Ababa, Ethiopia, Ministry of Agricultureand Rural Development.

Shenkute AG, Getachew Y, Assefa D, Adgaba N, Gebeyehu G, Abebe W (2012).Honey production systems (*Apis mellifera* L.) in Kaffa,Sheka and Benchi-Maji zones of Ethiopia. J. Agric. Ext. Rural Dev. 4(19):528-541.

SOS Sahel (2006). Community Initiative Promotion (CIP): Kaffa Development Programme (KDP). Synopsis of the study of selected sub sector in Kaffa Zone Ethiopia (Forest coffee, Honey and Cardamom).

Taye B, Marco V (2014). Assessment of constraints and opportunities of honey production in Wonchi District South West Shewa Zone of Oromia, Ethiopia. Am. J. Res. Commun. 2(10):342-353. www.usa-journals.com, ISSN: 2325-4076.

Teferi M, Yirga G, Hailemichael T, Amare S (2011). Prospects of Beekeeping in the Northern Ethiopian highlands. Sci. Res. Essays. 6(29):6039-6043.

Journal of Agricultural Extension and Rural Development
Related Journals Published by Academic Journals
■ Journal of Plant Breeding and Crop Science
■ African Journal of Agricultural Research
■ Journal of Horticulture and Forestry
■ International Journal of Livestock Production
■ International Journal of Fisheries and Aquaculture
■ Journal of Development and Agricultural Economics
academicJournals