Journal of Agricultural Extension and Rural Development Vol. 4(11), pp. 340-346, 27 June, 2012
Available online at http:// academicjournals.org/JAERD
DOI: 10.5897/JAERD11.111
ISSN- 2141 -2154 ©2012 Academic Journals

Full Length Research Paper

Farmers' evaluation of integrated soil fertility management methods in Northern Kasungu Central Malawi

Austin Tenthani Phiri[1]*, Wezi Grace Mhango[2], Joyce Prisca Njoloma[2], George Yobe Kanyama-Phiri[2] and Max William Lowole[2]

[1]Chitedze Agricultural Research Station, P. O. Box 158, Lilongwe, Malawi.
[2]Bunda College of Agriculture, University of Malawi, P. O. Box 219, Lilongwe, Malawi.

Accepted 29 December, 2011

There has been extensive recognition of the necessity to rejuvenate the fertility of soils for sustainable agricultural productivity, food security, household income and poverty alleviation in sub-Saharan Africa. In 2007, laboratory analytical results of the soils from Mkanakhoti extension area of Kasungu District, Central Malawi, indicated low levels of N, P and organic carbon (OC) and sandy texture. Socioeconomic data was collected and 40 on-farm experiments were also conducted. Integrated soil fertility management (ISFM) technologies tested on-farm included: pigeon pea biomass transfer in a maize field, pigeon pea/groundnut, maize/groundnut, maize/pigeon pea intercrops and maize treated with inorganic fertilizer. Initial assessments indicate wide-scale testing in the pilot areas and farmer adaptation and innovation of the options promoted. Farmers' rated: pigeon pea/groundnut intercrop as very good by 85% or good by 8%; maize/pigeon pea intercrop as very good 60% and good 18%; sole cropped maize with urea very good by 55% and good by 35% of farmers; and maize intercropped with groundnuts as the least preferred technology with 40% of the farmers ranking it as very good and 15% as good. Efforts are underway to scale out and up the efforts through farmer to farmer extension, field days, extending the legume best bets project to other districts in Malawi and sensitizing policy makers at a higher level on the outcomes of the project.

Key words: Pigeon pea, groundnut, maize, integrated soil fertility management, participatory evaluation.

INTRODUCTION

The smallholder agricultural sector in Malawi is characterized by low productivity and land constraints. Traditionally, African agricultural systems were largely based on extended fallows and the harvesting of nutrients stored in woody plants. The site to be cultivated was cleared by cutting and slashing plant growth, and then by burning the dried plant material (Blackie, 1994). Today, in most arable areas of Malawi, Zimbabwe and Kenya, fallowing is no longer being practiced (Kumwenda et. al., 1995), mostly due to population pressure, resulting in the fragmentation of land. In Malawi, the national mean land holding size has fallen from 1.53 ha per household in 1968 to 0.80 ha per household in 2000 (GoM, 2001). This has led to continuous cropping primarily of maize, the main cereal crop, resulting into low soil fertility in most cultivable soils. About 52.4% of Malawians live below poverty line, of 1US$/day (Government of Malawi, 2005). Such low incomes mean that few farmers can afford to use purchased inputs (in the absence of subsidies), and there is limited knowledge of organic matter technologies such as composting. Intercropping refers to the growing two or more crops at the same time on a single field (Machado, 2009). Intercropping is more stable than monocropping due to the partial restoration of diversity that is lost under monocropping. Other advantages of the system include; supression of weeds, soil erosion

*Corresponding author. E-mail: phiriaustin923@gmail.com.

control and reduced damage from pests and diseases (Machado, 2009). On the other hand, annual crop legumes, grown in rotation with cereal crops, can improve yields of the cereals and contribute to the total N pool in soil. Reported yield responses to previous legume crops are in the range of 50 to 80% increases over yields in cereal-cereal sequence (Hayat, 2005). In the light of the stipulated benefits confered by intercropping systems to the soil and in a bid to reverse the declining soil fertility and related crop productivity, intercropping technologies in rotation with maize were tested on farm and evaluated in Mkanakhothi Extension Planning Area (EPA) of north Kasungu in central Malawi under the legume best bets project.

The legume best bets project

A project titled "Legume best bets to acquire phosphorus and nitrogen and improve family nutrition" is being implemented in Malawi using participatory approaches. It covers the Northern and Central Regions of Malawi. In the North, it is being implemented in Ekwendeni area of Mzimba District while in Central Malawi, the project is being implemented in Mkanakhothi EPA of Kasungu Agricultural Development Division (KADD) in Kasungu District. In both study sites, farmers organized themselves into farmer research and outreach groups which have leadership structures that guide in decision making and in the implementation of development activities.

The project goal is to improve soil health and family nutrition by empowering farmers with knowledge to overcome food and nutrition insecurity. The purpose is to improve soil fertility for sustainable crop production and improved family nutrition. The integrated soil fertility management options that were evaluated include: Pigeon pea biomass transfer in a Maize field; Pigeon pea/ groundnut; Maize/groundnut intercrops, and maize-plus-fertilizer.

Three outputs are expected and these are:

1) Establish through baseline that studies the current socio-economic conditions, soil fertility levels and farmer management practices and to develop, test and verify with farmers the appropriate and sustainable soil management technologies
2) Disseminate verified soil management technologies and practices
3) Enhance capacity of the stakeholders to implement sustainable soil fertility management technologies

METHODOLOGY

Study site

Kasungu in Mkanakhothi extension planning area (EPA) (12° 35' S, 33° 31' E). Research sites were located in five villages of Kaunda (Kapopo section), Tchezo (Ofesi section), Chisazima (Ofesi section), Ndaya (Simulemba section) and Chaguma (Simulemba section). This semi-arid site falls within the Kasungu plain and receives an average annual rainfall of 680 mm. The rainy season spans from November to April. During the 2007/2008 growing season, a total of 760 mm was recorded. The dominant soils are Ultisols (Ustults) (MW Lowole, University of Malawi, personal communication). These have low organic matter content, low nitrogen and low to high available phosphorus content. They have poor structure because of the sandy texture of the top soil.

Rainfall data were obtained from the Ministry of Agriculture, Kasungu Rural Development Project (Figure 1). It was observed that the study area receives low amounts of rainfall and that dry spells are a common phenomenon with drought also being a common occurrence in the area.

Ten villages were randomly selected from within and in the proximity of the catchment area of the Malawi Enterprize Zone Association (MALEZA) to take part in the study. For each village, a list of farmers was prepared in collaboration with MALEZA staff and community agricultural workers (CAWs). Using Microsoft Excel program, farmers were randomly selected for household and farm field interviews. A total of 60 farmers were sampled and consent for their involvement in the proposed project activities was solicited.

Baseline study

Initially, a baseline survey was conducted to collect some socio-economic data. This was done using a structured interview schedule, developed by the legume best bets project team. Further, a wealth ranking exercise using focus group discussions was conducted in the participating villages to establish wealth categories that were in existence at that time (Mearns, 2001).

Soil was sampled from the topsoil (0 to 15 cm) and subsoil (15 to 30 cm) in each farmer's field from four randomly selected points. Soils were analyzed in the laboratory for OC, total N, available P, and soil pH (H_2O). Soil analysis for P was done using Mehlich-3 extraction procedures (Mehlich, 1984) while OC was determined using the colorimetric method (Schumacher, 2002) and total N was determined using Kjeldahl method (Amin and Flowers, 2004).

Experiments

On farm baby trials were implemented by 40 farmers which had treatments involving intercropping of pigeon pea, groundnut and maize in different combinations. Farmers were treated as replicates. The treatment were laid in a randomized complete block design and were as follows; maize only, maize + urea at 92 kg N ha^{-1}, maize + pigeon pea + pigeon pea biomass at 92 kg N ha^{-1}, pigeon pea + groundnut and maize + groundnut. Pigeon pea (long duration-ICEAP 04000) was sown at 90 cm within a row apart while groundnut (CG7-bunch type) was sown between the pigeon pea stations at 15 cm apart. One seed was sown per planting station of both legumes. Maize (ZM 621-open pollinated variety) was sown at 25 cm apart, one seed at each planting station. In the treatment that involved maize/groundnut intercropping, groundnut was sown 12.5 cm from a maize planting station. Ridge spacing was 75 cm for all treatments. The plot size was 10 m x 10 m.

The second stage involved a qualitative individual evaluation of the best bet technologies. This involved 40 farmers only. Other farmers (20) were not interviewed because their trial plots were poorly managed. During the exercise farmers were asked to provide information on challenges that they encountered during trial implementation. The socio-economic data was analyzed using the statistical package for social scientists (SPSS).

Farmer assessment of the technologies was carried out mid and end of season using a checklist and ranking. A scale of 1-4 was used to rate each technology whereby: 1= very good technology; 2= good; 3= poor; and 4= very poor technology.

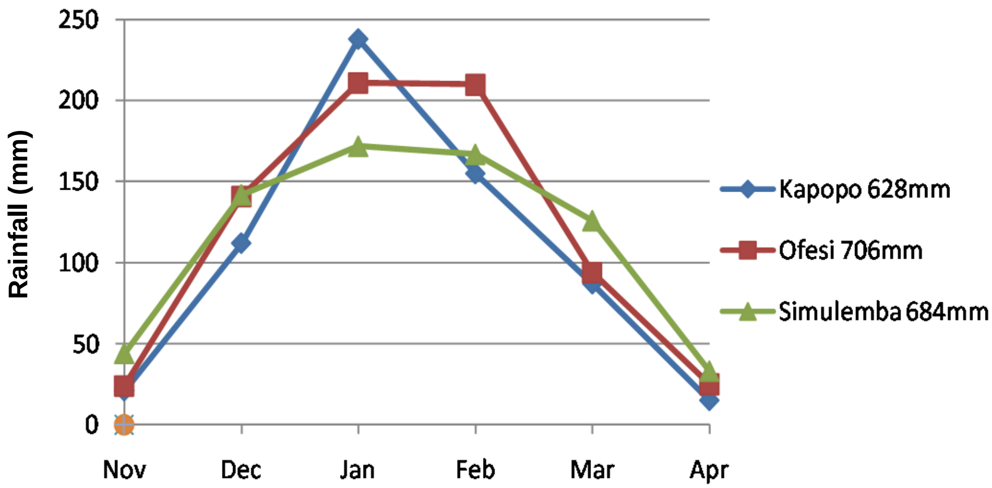

Figure 1. (Mean rainfall distribution over a period of seven years (2000/01 – 2007/08 in the study area).

RESULTS

Demographic information and legumes grown in the area

The survey indicated that 52% respondents were male and 48% female; 80% were living with their spouses, 15% were widowed, 2% single and 4% were polygamous. Age range was from 22 to 80 years with a mean of 40 years (SE=1.6). The study further revealed average household size was 6 persons per farm family with an average land holding size of 3.8 ha per household which is high when compared to the national average of 0.80 ha per household in 2000 (Government of Malawi, 2001).

From the study, it was noted that 86%, 91% and 89% of the respondents indicated that pigeon pea, soy bean and mucuna respectively were recently introduced in the study area. The order of preference of legume crops grown as follows: groundnut (91%), cow pea (82%), soy bean (78%), dwarf beans (72%), climbing beans (47%), pigeon peas (25%) and mucuna (15%). In the 2006/07 cropping season 82% of the households were food insecure while only 18% were food secure.

Education level

Only 2% went up to tertiary level, 15% attended secondary school education, 68% had attended primary school and dropped out before completing and 15% have never attended formal education. This trend could impact on technology adoption by the smallholder farmers. Level of literacy impacts technology adoption. Literate farmers are more likely to easily understand and grasp technical information that accompanies agricultural technologies than non literate farmers.

Household assets-type of house and dwelling unit

The type of housing units that households dwell is often used as an indicator of the level of wealth, well being and social status of the household (Ajayi et al., 2010). In this survey the type of roofing and wall were used to assess the quality of the dwelling units and wealth. Thatch roofed dwelling units with unburnt brick wall are common in the area (73%) with sporadic sights of thatch roofed with burnt brick dwelling units (14%) and iron sheet roofed with burnt brick dwelling units (14%). This indicated low wealth endowment on the community.

Household assets-ownership of livestock

Ownership of livestock is generally considered as an asset in the rural areas of Malawi. Livestock may be used as a risk buffering strategy in case of financial crisis (Ajayi et. al., 2010). Ten percent of the interviews own cattle. Over two-fifth own goats (45%) while a majority own chickens (94%). Over one-fifth keep guinea fowls (24%) and pigeons (28%). Sheep are rare in the area (2%) as well as swine (14%), rabbits (4%) and ducks (2%). Chicken and goats are the most commonly owned livestock in the area possibly due to their low cost of purchase, feeding and management. Management mostly is through free range.

Household food security and Income sources

In the 2006/2007 growing season only 18% of the farmers interviewed were food secure. The area was hit with prolonged dry spells that impinged crop production. Over four-fifth (80%) generate income through the selling

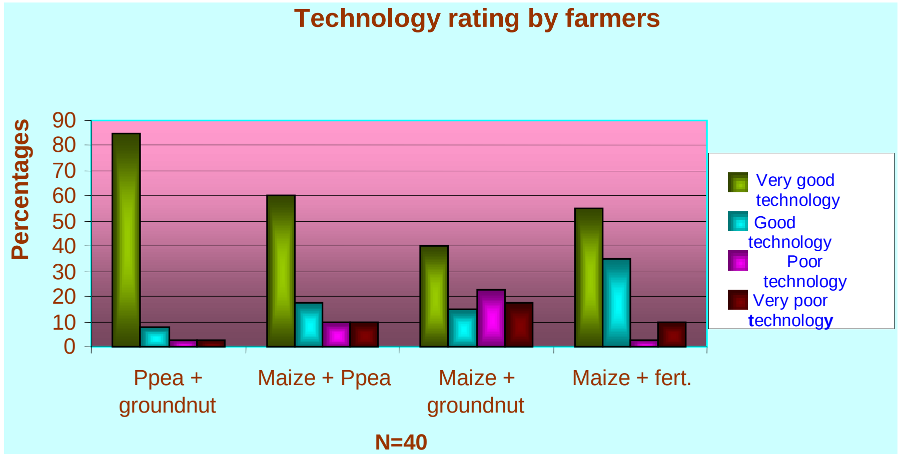

Figure 2. Farmer rating of technologies Ppea=Pigeon pea, Gnut=Groundnut, Fert.=Fertilizer, Tech.=Technology.

of agricultural produce. Other sources of income may include piece works (8%), remittances (2%), sale of firewood or other natural resources (2%), jobs (8%). The high dependency on agriculture for income, indicate that households have low resilience during hunger years as they may not have enough money for purchase of food from other food secure areas.

Wealth ranking

The study revealed high levels of poverty in the area. Wealth categories that were identified include; i) Farmers who are able to make ends meet, which means those who can afford three meals per day. ii) Farmers who are struggling to make ends meet, which means those who can afford two meals per day. iii) Farmers who cannot make ends meet, which means those who can manage a meal per day through piece work and iv) Extreme cases which means farmers who can be without food for a day or more. Table 1 contain a cross tabulation of the findings of the wealth ranking exercise conducted in the villages.

Soil characterization of the study area

Physical and chemical properties of the soil in the area

Table 2 summarize baseline physical and chemical properties of the soil in the area. Laboratory analytical results showed that soil pH ranged from 5.2 to 5.8 in top soils and from 5.1 to 5.7 in the sub soil; According to Brady and Weil (2008), the soils are acid to moderately acid. Available P varied widely across sites (2 to 60 mg P kg^{-1}). It was low both in top soils and subsoil. Texture classes were loamy sand, sandy loam to sandy clay loam, with sandy loam being the most prevalent texture class across sites. The organic matter ranged from 1.4 and 1.5%. These values were below the critical threshold of 2.5% (Greenland et al., 1975). However, the C:N ratio for top soil was 9:1, and this is close to a C:N ratio range of 10:1 to 12:1 which indicates a stable soil organic matter fraction (Kelly et al., 2005).

Farmer assessment of the technologies

Figure 2 shows farmers' assessment of the technologies. The study revealed that farmers' preferred technology was the 'doubled-up' legume pigeon pea/groundnut rated as very good or good by 85 and 8%, respectively. This was followed by maize/pigeon pea intercrop which was ranked as very good by 60% and good by a further 18% of farmers. These rankings exceed those of sole cropped maize with urea which was ranked as very good by 55% and good by 35% of farmers. Maize intercropped with groundnuts was the least preferred technology with 40% ranking it as very good and 15% as good. Reasons given by the farmers for their preference include: production of two crops (the staple, maize, and relish, pigeon pea) on the same plot without compromising maize yields; soil fertility boosted for next year's maize crop; vigorous maize plants and good yields expected. This implies that prospects are high for the households to achieve food, nutrition and income security. Over 70% of farmers involved in the trials were interested in growing more pigeon pea-groundnut intercrop and 50% in maize-pigeon pea while 52% were interested in growing more maize with fertiliser. A minority (15%) expressed interest in maize-groundnut intercrops (Figure 3).

Production constraints

During the growing season farmers experienced some

Table 1. Wealth ranking in Mkanakhothi EPA.

Name of village	Farmer category				
Chisazima				Making ends meet	Struggling to make it
	Number of farmer			32	50
	Percentage (%)			39.0	61.0
		Making ends meet	Struggling to Make ends meet	Cannot make ends meet	Extreme cases
Tchezo	Number of farmer	25	12	45	11
	Percentage (%)	26.9	12.9	48.4	11.8
		Making ends meet	Struggling to make ends meet	Cannot make ends meet	
Ndaya	Number of farmer	5	8	22	
	Percentage (%)	14.3	22.9	62.9	
		Making ends meet	Struggling to make ends meet	Cannot make ends meet	
Kaunda	Number of farmer	22	35	7	
	Percentage (%)	34.4	54.7	10.9	
		Struggling to make ends meet	Cannot make ends meet	Extreme cases	Making ends meet
Chaguma	Number of farmer	1	2	10	27
	Percentage (%)	2.5	5.0	25.0	67.5

NB: Making ends meet= Means can afford 3 meals per day; struggling to make ends meet; means can afford 2 meals per day; cannot make ends meet=means can manage a meal per day through piece work; extreme cases=means can be without food for a day or more.

challenges and these were captured at the end of the season. Constraints faced by farmers during the 2007/ 2008 season included: poor seed viability (85%) of the maize seed. This resulted in low maize yield. Other factors were pests (50%), diseases (30%), striga – weed (18%) and inadequate rainfall (40%).

DISCUSSION

The study revealed that the area still has enough arable land with an average land holding size of 3.8 ha per household. This is markedly high when compared to the national average of 0.80 ha per household in 2000 (Government of Malawi, 2001). This implies that with proper farm land budgeting opportunity abounds for farmers to utilize the double legume intercrop maize rotation cropping system as a tool for boosting soil fertility for increased crop production for food, nutrition and income security.

On technology adoption, of concern is the low levels of literacy. The study indicate that the majority of the farmers (68%) had attended primary school and dropped out before completing while 15% have never attended formal education.

Potential for low technology adoption by the smallholder farmers is high. Level of literacy impacts technology adoption. Literate farmers are more likely to easily understand and grasp technical information that accompanies agricultural technologies than non literate farmers. Farmers in the area depend highly on crop production for income. Furthermore small livestock like chickens and goats are the most commonly owned livestock in the area. This implies that during hunger years farmers may not earn enough money from the sale of the small livestock for the purchase of food from other food secure areas. Additionally, the wealth ranking exercise revealed high levels of poverty. The aforementioned indicates that the community has a low capacity to cope with harsh economic and climatic conditions.

CONCLUSION AND RECOMMENDATIONS

The testing on-farm of various inorganic and organic sources of nutrients by farmers in northern Kasungu, central Malawi seem to yield useful learning experience to both farmers and the Legumes best bet project members. There is opportunity for farmers to integrate the soil fertility management options being promoted in the

Table 2. Site specific soil parameters.

Village	Section	Depth (cm)							
		0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
		pH		OC (%)		Available P (mg kg^{-1})		Total N (%)	
Kaunda1	Kapopo	5.5	5.3	0.6	0.6	62	24	0.05	0.05
Kaunda 2	Kapopo	5.8	5.7	0.9	0.6	8	6	0.08	0.07
Tchezo	Ofesi	5.6	5.5	0.8	0.6	30	26	0.08	0.06
Chisazima 1	Ofesi	5.3	5.1	0.8	0.6	2	2	0.06	0.06
Chisazima 2	Ofesi	5.7	5.6	0.5	0.6	4	2	0.04	0.03
Ndaya 1	Simulemba	5.4	5.3	1.5	0.6	11	2	0.10	0.10
Ndaya 2	Simulemba	5.3	5.1	0.8	0.6	14	3	0.07	0.07
Chaguma	Simulemba	5.2	5.1	1.2	0.6	14	13	0.10	0.10
Mean	-	5.4	5.3	1.5	1.4	18	9.6	0.07	0.07
Std. dev	-	0.21	0.24	0.5	0.5	0.36	0.34	0.02	0.02

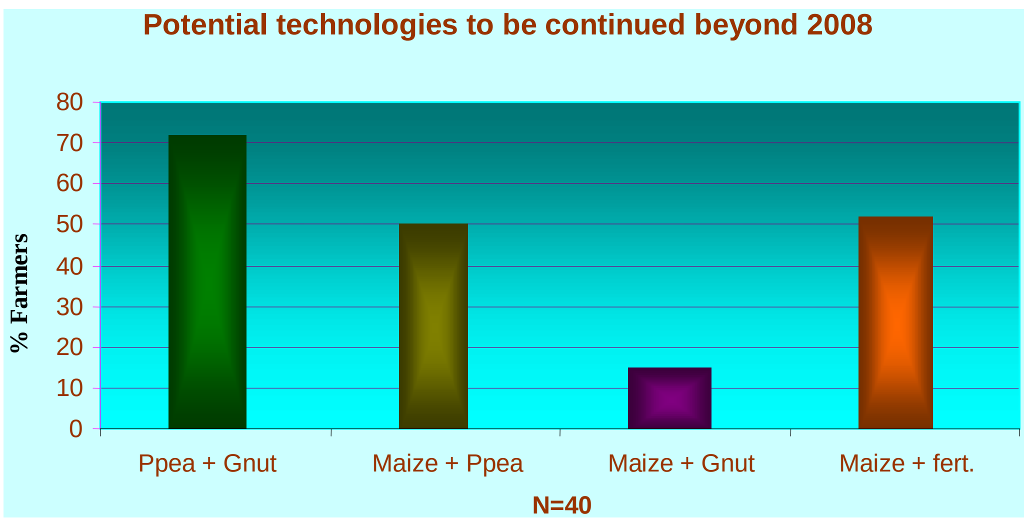

Figure 3. Farmer interest in technologies Ppea=Pigeon pea, Gnut=Groundnut, Fert.=Fertilizer.

area given the fact that land holding size per household is not limiting. However, challenges along the way towards the adoption of the innovations are present. Among which is the low resource endowment of the general community and low literacy levels. Notwithstanding the same, apparently, potential is there to surmount these impedements to adoption of the technologies. For instance, the legume best bets project has empowered farmers to take lead in the dissemination of technologies to a wide audience. Fruits of this initiative are beginning to manifest. For instance, farmers in the area are now willing to start growing pigeon pea, a crop often viewed by farmers in the central region of Malawi as “a crop for farmers in the southern region of Malawi”. Understanding of farmer priorities and constraints, decision making and how farmer’s trade-off production technologies with their time, will be increasingly important in targeting interventions/technologies to smallholder farmers. The legume best bets project needs to refine these technologies through participatory technology testing approaches to promote adaptability to farmers conditions and empower farmers with sustainable integrated soil fertility management (ISFM) practices that includes a plan to ensure seed adequacy.

ACKNOWLEDGEMENTS

The authors would cordially like to thank the McKnight Foundation for funding the work, the collaborative efforts by the Malawi Enterprise Zone Association (MALEZA) in conducting field activities, farmers and agricultural extension staff in Mkanakhothi Agricultural Extension Planning Area (EPA) in Kasungu Central Malawi.

REFERENCES

Ajayi OC, Akinnifesi FK, Sileshi G, Mn’gomba S, Place F, Gondwe FMT, Kambauwa G, Gama S, Makumba W, Chaula K (2010). Agroforestry Food Security Programme (AFSP), Baseline Survey Report-ICRAF.

Amin M, Flowers TH (2004). Evaluation of the Kjeldahl Digestion Method. J. Res. Sci. 15(2):159-179.

Blackie MJ, (1994) Maize productivity for the 21st century: the African challenge. Outlook on Agric. 23:189-195.

Brady N, Weil R (2008). The Nature and Properties of Soils. 14th ed. Prentice Hall, Upper Saddle River, NJ. ISBN 13-978-0-13-227938-3. P 975.

Greenland DJ, Rimmer D, Payne D (1975). Determination of the Structural Stability Class of the English and Welsh Soils, using a water coherent test. J. Soil Sci. 26:294-303.

GoM (Government of Malawi) (2001). State of Environment Report for Malawi 2001, Lilongwe: Ministry of Natural Resources and Environmental Affairs.

Hayat R (2005). Sustainable legume-cereal cropping system through management of biological nitrogen fixation in Pothwar. PhD thesis, University of Arid Agriculture, Rawalpindi.

Kelly KM, Johan S, William RH, Chris VK (2005). Role of Mineral-Nitrogen in Residue Decomposition and Stable Soil Organic Matter Formation.

Kumwenda JDT, Waddington SR, Stephen R, Snapp SS, Jones RB, Richard B, Blackie MJ (1995). Soil Fertility Management In The Smallholder Maize-Based Cropping Systems Of Africa. A paper for a Workshop on “The Emerging Maize Revolution in Africa: The Role of Technology, Institutions and Policy” Michigan State University, USA, 9-12.

Machado S (2009). Does intercropping have a role in modern agriculture? J. Soil Water Conserv. 64:2.

Mearns R, Shombodon D, Narangerel G, Turul U, Enkhamgalan A, Myagmarzhav B, Bayanjargal A, Bekhsuren B (2001). Direct and indirect uses of wealth ranking in Mongolia. PLA Notes CD-ROM 1988–2001. Pp. 1-9

Mehlich A (1984). Mehlich 3 Soil Test Extractant: A modification of Mehlich 2 Extractant. Commun. Soil Sci. Plant Anal. 15(12):1409-1416.

National Academy of Science, (1994). Biological Nitrogen Fixation. National Academy Press, Washington, DC.

Schumacher BA (2002). Method for the determination of total organic carbon (TOC) in soils and sediments. United States Environmental Protection Agency Environmental Sciences Division National Exposure Research Laboratory, Las Vegas. pp. 4-25.