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Journal Seek, Scientific Commons, and
Food and Agricultural Organization (FAO)

Journal of Agricultural Extension
Vol. 19 (2) December, 2015
ISSN(e): 24086851; ISSN(Print); 1119944X
http://journal.aesonnigeria.org
http://www.ajol.info/index.php/jae
Email: editorinchief@aesonnigeria.org

http://dx.doi.org/10.4314/jae.v19i2.4

Evaluation of Crop-Livestock Integration Systems among Farm Families at Adopted Villages of the National Agricultural Extension and Research Liaison Services

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Abstract

This study evaluated the level of access to knowledge, farm assets and inputs utilization in crop-livestock integration systems (CLIS) among rural farm families at NAERLS adopted villages. A total of 120 farm families were interviewed through structured questionnaire. Forty farm families were randomly chosen from two adopted villages each in South West, North Central and North West zones of NAERLS. The data obtained were analysed by frequency counts, percentages, means and standard error of the means. The results showed, among others, that 95.8% of farmers interviewed were aware of CLIS. Mixed cropping (70%) was majorly practiced. Cereals were cultivated at higher rates (88.3%) in all the agro-ecological zones. Poultry ranked highest (54.2%) among all the livestock being kept by the farmers. Farmers at NAERLS adopted villages practiced CLIS at subsistent level based on their indigenous knowledge and technology. The existing practices of CLIS by farmers at NAERLS adopted villages should be packaged into a model that can encourage profitability and sustainability of integration of crops and livestock.

Keywords: Crop-livestock integration systems, adopted village, farm family.

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Introduction

Population growth, urbanization and income growth in developing countries are fuelling a substantial global increase in the demand for food of animal origin, while also aggravating the competition between crops and livestock through increasing cropping areas and reducing rangelands (Rota and Sprerandini, 2010). Demand for food is expected to continue to increase for at least the next 40 years (Godfray *et al*., 2010) and food production will need to increase by 70 to 100% by 2050 (World Bank, 2008). However, this has to be done in the face of growing competition for land, water, and energy, and without harming the environment. The objective must therefore be sustainable intensification of agricultural production (The Royal Society, 2009).

Integration of different system components minimizes use of agrochemicals, reduces the opening of new areas for crop-livestock, and prevents environmental liabilities. It enables increase in biodiversity, and allows a better control of erosion through soil coverage. Integrating livestock and crop production is a form of conservation agriculture, which enables shifting from the traditional systems which is focused exclusively on livestock or crop to a new approach which sustainably combines both. Crop-livestock integration may represent a model of sustainable farming according to principles of nutrient recycling and efficient use of land and resources (Moraine *et al*., 2014). Crop-livestock integration also plays a supporting role in other beneficial cropping practices as some techniques, such as growing green manures, cover crops and annual and perennial forages, become more financially attractive when livestock products can be gained from the system (Chen *et al*., 2012).

Crop-livestock integration involves more than the production of both crops and livestock on the same farm. Rather, the goal of such systems is integration of function rather than mere diversification (Schiere *et al*., 2006). These functions involve nutrient cycling, consumption and processing of crop residues, and pest management (for both crops and livestock), among others. The benefits of crop-livestock integration also extend beyond these functions and include increased income and income stability (Franzluebbers and Stuedemann, 2007; Russelle *et al*., 2007) as well as the potential to reduce greenhouse gas emissions from both crop and livestock systems (Asgedom and Kebreab, 2011).

It is understandable that crop-livestock integration system is often considered as a step forward in effective utilization of resources, but smallholder farmers need to have sufficient access to knowledge, required assets and inputs to manage this system in a way that is economically and environmentally sustainable over a long term. This study was therefore designed to evaluate the level of access to knowledge, farm assets and inputs utilization in crop-livestock integration systems among rural farm families at NAERLS adopted villages.

The specific objectives were to:

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1. Evaluate the socioeconomic characteristics of farmers at NAERLS adopted villages.

2. Identify crop-livestock systems being practiced by rural farm families at NAERLS adopted villages.

3. Determine the economic benefits of crop-livestock integration systems at NAERLS adopted villages.

Methodology

The target population for this study was all the rural farm families who engaged in either or both of crop and livestock production at NAERLS adopted villages in Nigeria. NAERLS has a total of 36 adopted villages spread all across the six zones of the institute. Three zones (North West, North Central and South West) of the institute were purposively selected because of their prominence in crop and livestock production. From each of the three zones, two adopted villages were purposively selected because some of the NAERLS zones do not have more than two adopted villages. The adopted villages, their respective local Government Area, State and NAERLS zone were as stated in Table 1 below:

Table 1: Adopted villages selected for the study

S/No.	Name of adopted village	Local Government Area	State	NAERLS Zone
1.	Guga	Giwa	Kaduna	North West
2.	Unguwwa Maigamo	Giwa	Kaduna	North West
3.	Gbakogi Kasara	Katcha	Niger	North Central
4.	Nworgi	Katcha	Niger	North Central
5.	Dagilegbo Okolo	Ibarapa East	Oyo	South West
6.	Koguo	Iddo	Oyo	South West

Twenty farm families were randomly selected in each of the adopted village to make a total of 120 respondents. Structured questionnaire was developed and validated on the basis of the specific objectives of the study and it was used to interview a member of each selected family. The data obtained were analyzed using frequency counts, percentages, means and standard error of the means.

Results and Discussion

Socio-economic characteristics of respondents

Table 2 showed the socio-economic characteristics of farmers at NAERLS adopted villages. Most of the farmers interviewed were male (87.5%). The average age of the respondents was 43±1 years. They were mostly (85.8%) distributed within 20 to 49 years old and were married (92.5%). This is an indication that most of the respondents are young, vibrant and capable of accepting new innovations in the form of crop-livestock integration systems.

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The average household size was 8. This implies that the labour required for the crop-livestock integration systems could be obtained within the family. All the respondents had some form of education starting from Qu'ranic (25.8%), primary (38.3%), secondary (25.8%) and tertiary education (10%). These results are in agreement with Chi and Yamada (2002) who stated that age, education attainment and family size positively influenced the adoption of agricultural technologies.

Farming was the primary occupation of most (73.3%) of the respondents. About 80% of them cultivated crops alongside livestock rearing. This is an indication that the farmers are capable of accepting the crop livestock integration system, since they are already practicing some form of mixed farming. Average farm size among those that engaged in crop production was 4±1 hectares while the average income per month of the rural farm families was ₦24,000.00±2109.10.

Components of crop-livestock integration systems

Table 3 showed the components of crop-livestock integration systems at NAERLS adopted villages. Nearly all the respondents (95.8%) stated that they are aware of crop-livestock integration as a form of mixed agriculture. They feed their livestock with products or by-products of crop production. In fulfilling the dynamism of the cyclic interactions in crop-livestock integration; the farmers also engaged in fertilization of their farmland with products or by-products from livestock production. The major cropping system among rural farm families in the study area is mixed cropping (70%). However, many farmers (72.5%) in North Central agro-ecological zone practice relay cropping whereby a second crop is planted at about the time when the first crop is being harvested.

Crop residues obtainable from crop production activities in the entire studied populations were majorly from cereals (88.3%). Residues from legumes were indicated as more prominent (92.5%) than what is obtainable from cereals (87.5%) in North Central agro-ecological zone. Residues from roots and tubers (cassava, yam and cocoyam) were reportedly obtainable in large quantity by 85% of the respondents. Whereas, residues from vegetables (10%) and forage crops (2.5%) were lowly reported by respondents all across the three agro-ecological zones studied. The availability of crop residues to meet the nutrient requirement of the livestock in the three agro-ecological zones supports the adoption of the crop-livestock integration system. The availability of crop residues represents one of the pillar on which the equilibrium of this system rests. They are fibrous by-products that result from the cultivation of cereals, pulses, oil plants, roots and tubers.

For resource-poor farmers, the correct management of crop residues, together with an optimal allocation of scarce resources, leads to sustainable production. Combining ecological sustainability and economic viability, the integrated livestock-farming system maintains and improves agricultural productivity while reducing negative environmental impacts. In an integrated system, livestock and crops are produced within a coordinated framework. (Van Keulen and

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Schiere, 2004). The waste products of one component serve as a resource for the other. For example, manure is used to enhance crop production; crop residues and by-products are used to feed the animals, supplementing inadequate feed supplies, thus contributing to improved animal nutrition and productivity.

The result of this cyclical combination is the mixed farming system, which exists in many forms and represents the largest category of livestock systems in the world in terms of animal number, productivity and the number of people it services (Van Keulen and Schiere, 2004). Livestock play key and multiple roles in the functioning of the farm, not only because they provide livestock products (meat, milk, eggs, wool, and hides) but they can be converted into prompt cash in times of need. Livestock transform plant energy into useful work: animal power is used for ploughing, transport and in activities such as milling, logging, road construction, marketing, and water lifting for irrigation. Livestock also provide manure and other types of animal waste.

Livestock production was majorly done through semi intensive (54.2%) and extensive system (40.8%). There were few cases of intensive system being practiced by rural farmers in South West (5%) and North West (2.5%). Since the predominant system of livestock production is semi intensive, the practice of allowing livestock to defecate in the morning after feeding before releasing them to roam will enhance accumulation and easy collection of manure. Such manure is often regarded as one of the most important by-products from livestock production. Local poultry species was the most prominent (54.2%) livestock being reared in the rural villages of the entire population studied. However, swine production was reported by more than half (57.5%) of the respondents in the South West, Nigeria. A sizeable number of respondents reported rearing of sheep (42.5%) and goats (40%) in the North West agro-ecological zone and 32.5% reared goats in the North Central zone of Nigeria. Small ruminants are supposedly more suitable for crop-livestock integration system because of their ability to efficiently utilize cellulolytic fibrous materials in crop residues to produce manure. Cattle production was limited to 10% as reported by rural farmers in North West and 2.5% for each of North Central and South West. This is an indication of the availability of various sources of manure which are rich in nitrogenous compounds (urea) especially that of Poultry.

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Table 2: Socioeconomic characteristics of farmers at NAERLS adopted villages

Variables	Agro-ecological zone (State) (n=120)				
	North West (%)	North Central (%)	South West (%)	Overall (%)	Mean±SEM
Sex					
Male	87.5	100.0	75.0	87.5	
Female	12.5	0.0	25.0	12.5	
Age (year)					
Less than 20	2.5	5.0	0.0	2.5	
20 – 29	7.5	25.0	11.7	11.7	43±1
30 – 39	27.5	30.0	23.3	23.3	
40 – 49	35.0	25.5	30.0	30.0	
50 – 59	17.5	10.0	20.8	20.8	
60 – 69	10.0	2.5	9.2	9.2	
70 and above	0.0	0.0	2.5	2.5	
Marital Status					
Single	5.0	12.5	2.5	6.7	
Married	92.5	87.5	97.5	92.5	
Widowed	2.5	00.0	0.0	0.8	
Household size					
Less than 10	52.5	67.5	90.0	70.0	8±0.41
10 – 20	47.5	32.5	10.0	30.0	
Educational status					
Qu'ranic	42.5	27.5	7.5	25.8	
Primary	10.0	55.0	50.0	38.3	
Secondary	20.0	15.0	42.5	25.8	
Tertiary	27.5	2.5	0.0	10.0	
Primary occupation					
Farming	77.5	67.5	75.0	73.3	
Civil service	12.5	12.5	10.0	11.7	
Trading/Business	10.0	20.0	15.0	15.0	
Type of farming					
Crop only	17.5	5.0	27.5	16.7	
Livestock only	7.3	0.0	7.5	5.0	
Crop and livestock	75.0	95.0	65.0	78.3	
Farm size (ha)	n = 37	n = 40	n = 37	n = 114	
Less than 1	12.5	17.5	0.0	10.0	4±0.28
1 – 5	62.5	50.0	70.0	60.8	
6 – 10	15.0	22.5	17.5	18.3	
Above 10	2.5	10.0	5.0	5.8	
Monthly income (₦)					
Less than 5,000	7.5	67.5	0.0	25.0	24,000.00±2109.10
5,000 – 50,000	62.5	32.5	100.0	65.0	
50,001 – 100,000	27.5	0.0	0.0	9.2	
Above 100,000	2.5	0.0	0.0	0.8	

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Table 3: Components of crop-livestock integration systems at NAERLS adopted villages

Variables	Agro-ecological zone (State)			
	North West (%)	North Central (%)	South West (%)	Overall
Awareness of crop -livestock integration systems				
Yes	100.	95.0	92.5	95.8
No	0.0	5.0	7.5	4.2
Feeding of livestock with products/by products from crop production				
Yes	90.0	92.5	70.0	84.2
No	10.0	7.5	30.0	15.8
Fertilization of farmland with products/by products from livestock production				
Yes	87.5	100.0	147.5	78.3
No	12.5	0.0	52.5	21.7
Cropping system				
Sole cropping	12.5	0.0	5.0	5.8
Mixed cropping	87.5	27.5	95.0	70.0
Relay cropping	0.0	72.5	0.0	24.2
Crop residues obtainable from crop production activities				
Cereals	90.0	87.5	87.5	88.3
Legumes	40.0	92.5	5.0	45.8
Roots and tubers	17.5	27.5	85.0	43.3
Vegetables	12.5	10.0	7.5	10.0
Forage and pastures	2.5	0.0	5.0	2.5
Livestock production system				
Extensive	40.0	50.0	32.5	40.8
Semi intensive	57.5	50.0	55.0	54.2
Intensive	2.5	0.0	12.5	5.0
Species of livestock being reared				
Cattle	10.0	2.5	2.5	5.0
Sheep	42.5	7.5	0.0	16.7
Goats	40.0	32.5	2.5	25.0
Poultry	52.5	77.5	32.5	54.2
Swine	0.0	2.5	57.5	20.0

Levels of activities of crop-livestock integration system at NAERLS adopted villages

Figures 1a-f showed various activities captured in crop-livestock integration systems at NAERLS adopted villages. Most farmers in North West (90%) practiced fertilization of their farmland with organic manures. The use of organic manure was however lowly reported (10%) among farmers of adopted villages in the South Western part of Nigeria. Nearly all the farmers of adopted villages in the North West (97.5%) and North Central (72.5%) stored their crop residues for usage at a later time of the year when crop residues are not readily available. This ensures availability of livestock feed even in the dry season. Covering of soil with crop residues was highly reported in North West (77.5%) and moderately reported in South West (55%) and North Central (52.5%). A recurring situation in many parts of Nigeria is periodic and prolonged drought.

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This can lead to large livestock losses due to limited availability of forage and the weakened state of livestock arising from low body reserves. The loss of animals through death or distress sales reduces the quantity of manure available for recycling.

Land preparation using animal traction was a practice of choice by rural farmers in North West (80%) and North Central (65%). However, the practice was reported as non-existence in the South West (0.0%) of Nigeria. More farmers in the NAERLS adopted villages of North West (85%) processed their crop residues before feeding it to livestock. This was higher than what was reported in North Central (17.5%) and South West (2.5%) for the practice. Feeding of livestock with crop residues were moderately reported in all the populations studied. About half of the respondents in North Central (55%), North West and South West (52.5%) reported the practice (Figure 1f).

Obtainable benefits from crop-livestock integration system

Figures 3a-f was used to express the many benefits derivable from crop-livestock integration systems in adopted villages of three agro-ecological zones of NAERLS, Nigeria. Increase in family income was reported by 42.5% in North West and 32.5% in North Central zone. Only 2.5% in South West indicated the effect of the system as means of improving their family income (Figure 3a). Nearly all the respondents in each of the three zones stated that the system improves their soil (Figure 3b). It was almost a unanimous response in North Central (97.5) and North West (90%).

The system was reported to have been able to reduce the cost of feeding livestock in all the agro-ecological zones studied (Figure 3c). The proportion of respondents in North West (75%) and South West (70%) who responded to the capacity of the system to reduce cost of feeding of livestock was however higher than those of the North Central (35%). The system was also said to reduce time spent on land preparation (Figure 3d) in North West (72.5%) and North Central (52.5%). However, the proportion of those who observed reduction in time spent on land preparation in South West was low (28%). Increase in crop yield (Figure 3e) was reported in North West (72.5%) and North Central (65%). This benefit was not observed in the South West. However, there was an increase in animal products (Figure 3f) in all the agro-ecological zones. Most farmers in the North West (90%) reported increase in the obtainable animal products due to the crop-livestock integration systems.

The benefits of crop-livestock integration also extend beyond these functions and include increased income and income stability (Franzluebbers and Stuedemann, 2007; Russelle *et al*., 2007) as well as the potential to reduce greenhouse gas emissions from both crop and livestock systems (Asgedom and Kebreab, 2011). Full integration of crop and livestock production offers the greatest potential for increasing agricultural productivity, especially in the sub-humid and wetter parts of the semiarid zones (Powell and Williams, 1995).

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Crop-livestock integration also plays a supporting role in other beneficial cropping practices as some techniques, such as growing green manures, cover crops and annual and perennial forages, become more financially attractive when livestock products can be gained from the system (Chen *et al*., 2012). While forage crops and ruminant livestock are commonly integrated in perennial forage based systems, many other possibilities exist. For instance, annual cropping systems also offer many opportunities for integration of ruminants, and pigs and poultry can provide unique services such as rooting (tillage) and selective weed grazing or insect predation. Ecological functions may be enhanced even further when livestock are integrated into more complex systems; there are exciting examples from around the world of crop-livestock systems involving agro forestry and even aquaculture (Entz and Martens, 2009). Optimization of crop livestock systems requires further exploration of the relationships among soil, crops and livestock, including topics such as the role of nutrient transformation and redistribution by livestock, management of forage and crop legumes in the farming systems. The effects of specific grazing strategies on soil health, and the role of livestock in management of specific weeds.

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Figure 1a: Fertilization of farmland with organic manure

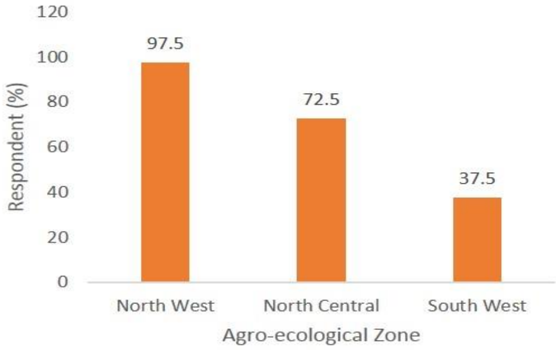

Figure 1b: Storage of crop residues

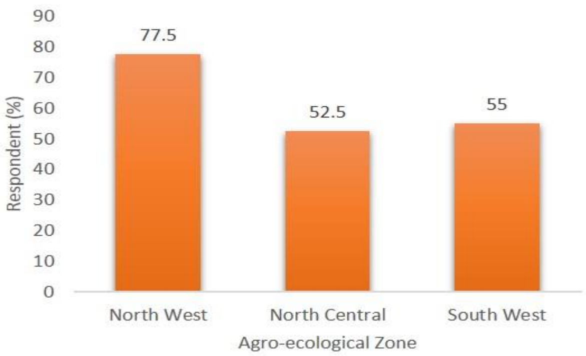

Figure 1c: Covering of soil with crop residues

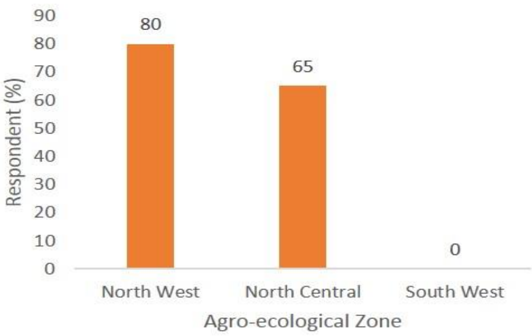

Figure 1d: Land preparation using animal traction

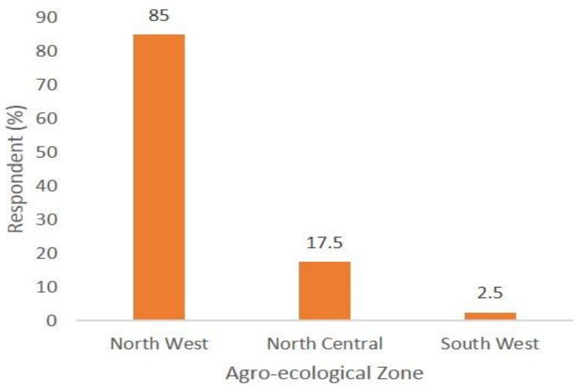

Figure 1e: Processing of crop residues

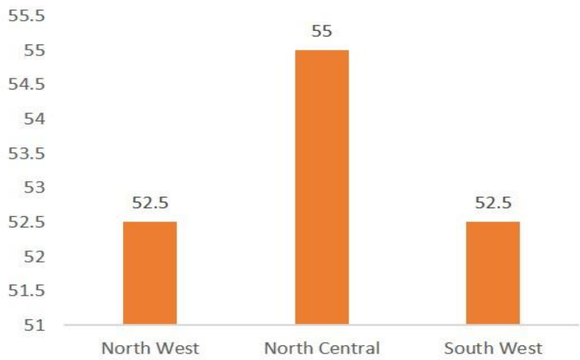

Figure 1f: Feeding of livestock with crop residues

Figures 1a-f: Various activities captured in crop-livestock integration systems at NAERLS adopted villages

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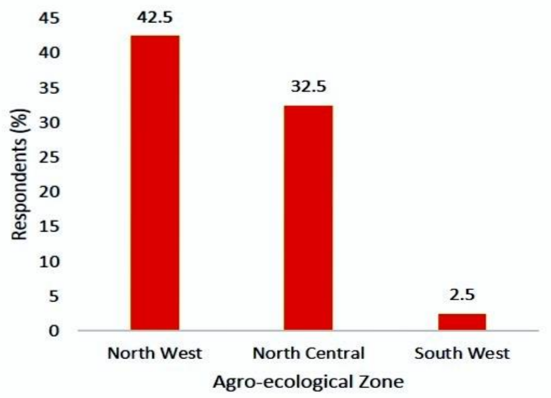

Figure 3a: Increase in family income

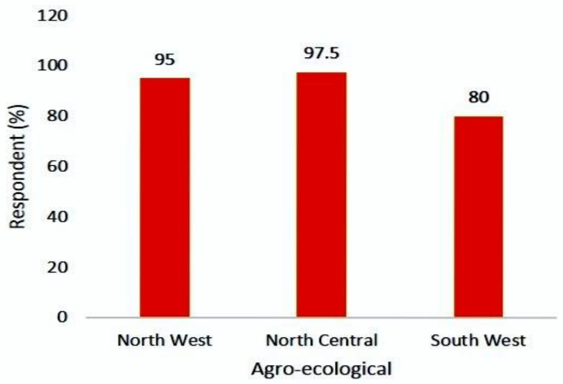

Figure 3b: Soil improvement

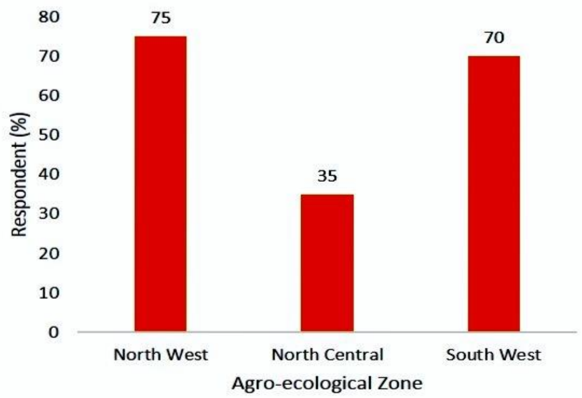

Figure 3c: Reduction in cost of feeding livestock

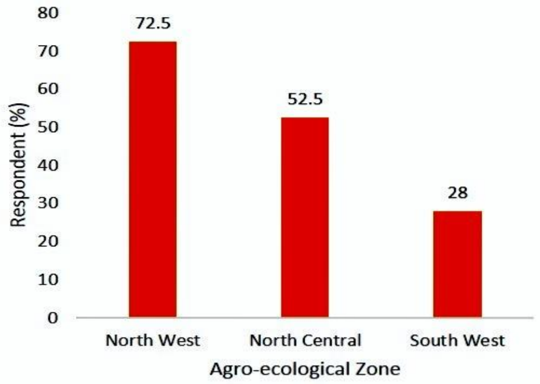

Figure 3d: Reduction in time spent on land preparation

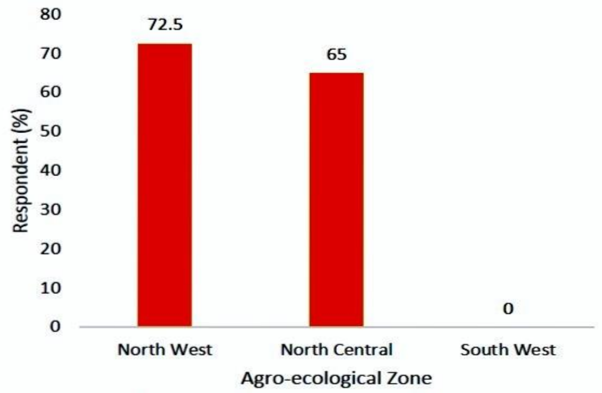

Figure 3e: Increase in crop yield

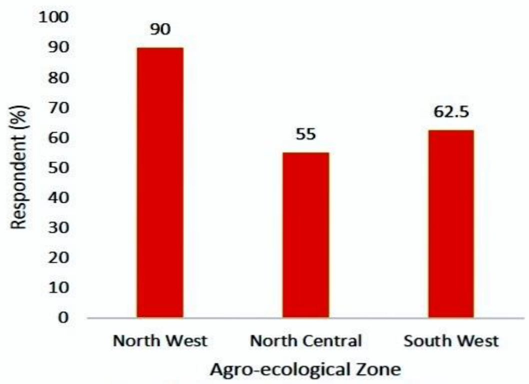

Figure 3f: Increase in animal products

Figures 3a-f: Benefits derived from crop-livestock integration systems

Conclusion and Recommendation

Farmers at NAERLS adopted villages practiced CLIS at subsistent level based on their indigenous knowledge and technology. The existing practices of CLIS

Journal of Agricultural Extension
Vol. 19 (2) December, 2015
ISSN(e): 24086851; ISSN(Print); 1119944X
http://journal.aesonnigeria.org
http://www.ajol.info/index.php/jae
Email: editorinchief@aesonnigeria.org

by farmers at NAERLS adopted villages should be packaged into a model that can encourage profitability and sustainability of integration of crops and livestock.

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