Gender Differences in Labor Allocation in West Africa:
A Case Study of the Savannas of Northern Nigeria

[1]Jonas N. Chianu and [2] Hiroshi Tsujii

[1]TSBF-CIAT, c/o World Agroforestry Centre (ICRAF),
UN Avenue, Gigiri, P.O. Box 30677-00100, Nairobi, Kenya
[2]Section of Bioresources Management, Faculty of Bioresources,
Ishikwa Prefectural University, 1-308 Suematsu, Nonoichicho, Ishikawagun, Japan 921-8836

Abstract: Boserup's influential book 'Women's Role in Economic Development' generated debate on gender and development in Africa. Based on a survey of 322 households in northern Nigeria, this paper evaluates gender differences in labor allocation to eight enterprises (crop production, livestock production, processing, fuelwood activities, food gathering, trading, non-farm activities and salaried job) using weighted arithmetic mean. Results indicate that labor allocation to crop production and processing followed sex lines: men allocated most of their labor to crop production (71% by male children, 81% adult males). Women allocated most of their labor to processing (36% female children, 57% adult females). The high concentration of men's labor on crop production is strong evidence that men, not women alone (as earlier suggested) play important role in agricultural production. The study concluded with research and policy implications of the observed labor allocation patterns.

Key words: Gender · labor allocation · enterprises · weighted arithmetic mean · Nigeria

INTRODUCTION

Since the publication of Boserup's [1] influential book 'Women's Role in Economic Development' and following the key statements contained in it such as that 'women play the dominant role in food production in Africa', several researchers working in Africa have turned their attention to issues of gender and development. Spencer [2] studied a new rice production project in Sierra Leone, collecting data on workload by gender. His findings indicate that while the workload of women in households participating in the project increased only slightly, the workload of men and male children increased substantially. Spencer, therefore, rejected Boserup's hypothesis that women's workload increases relative to men's as commercialization of agriculture proceeds. However, in results similar to Boserup's observation, Snyder [3] noted that women produced 80% of the food in Africa. Nweke *et al*. [4], while noting that Snyder's assertion was unencumbered with hard empirical evidence, observed that men provided more than half of the labor on cassava fields in five of the six countries surveyed in the Collaborative Study of Cassava in Africa (COSCA). However, the views of Snyder and Boserup were supported by a recent report by the World Bank that African women perform 90% of the work of hoeing and weeding [5].

Two important issues can be discerned from the above. First is the concentration of the gender and development studies on agriculture (especially crop production) and on intra-household labor allocations to activities (land clearing, planting, weeding, etc.) related to crop production [2, 4] to the neglect of the other rural enterprises such as agricultural

Corresponding Author: Dr. Jonas N. Chianu, TSBF-CIAT, c/o World Agroforestry Centre (ICRAF), UN Avenue, Gigiri, P.O. Box 30677-00100, Nairobi, Kenya

produce processing, trading, etc., that are equally important for overall rural development in Africa. These enterprises compete with crop production for household labor allocation. Farm households cannot easily increase access to labor through hired labor because agricultural credit is currently being de-emphasized by international donor agencies [5, 6] Secondly, the debate on gender and development in Africa is still on. There is, therefore, a clear need for further research.

This paper investigates the gender differences in household labor allocation to important rural enterprises (crop production, livestock production, agricultural produce processing, fuelwood and charcoal business, food gathering and hunting, trading, other non-farm activities such as transportation and salaried jobs) in the savannas of northern Nigeria. Such information can guide the development and targeting of improved agricultural technologies and other interventions aimed at off-farm income diversification to increase food security and protect the environment. In addition, the results can provide useful information that could assist in reducing the rate at which farmers reject improved agricultural and environmental protection technologies due to a mismatch with household labor allocation patterns.

METHODOLOGY

The study area: This study was carried out in 2002 in eight villages (Muriga, Doka, Galma, Matsirga, Yelwa Danzial, Dan Hassan, Wailare and Runa) selected from the Guinea and Sudan savannas of northern Nigeria. These are the two major savanna agroecological classifications in sub-Saharan Africa. The first four villages are located in Kaduna State (Guinea savanna) and have 600-1200 mm rainfall. The last four villages are in Kano State (Sudan savanna) and have a rainfall of 300-600 mm. Rainfall is unimodally distributed in both ecologies. The length of growing period is 150-200 days (Guinea savanna) and 90-150 days (Sudan savanna). Kaduna State lies between latitudes 9°04` to 11°50` N and longitude 6°09` to 10°41` E. Kano State lies between latitudes 10°33` to 12°37`N and longitude 7°34` to 9°25`E. The selected villages are representative villages in the two savannas and surveys of farm households were conducted to capture the effect of ecological and other factors on labor allocation pattern to enterprises by gender (defined below).

Traditionally, rural households in West Africa mostly derive their livelihood by engaging in crop and livestock production. The need to increase household income has, however, led many farm households to begin to add value to their agricultural produce through processing. Besides, many farm households have continued to embark on food gathering and hunting as well as some extractive activities. Farmers are also beginning to engage in off-farm diversification into activities such as trading to supplement farm income.

Based on the above, we investigated the labor allocation patterns to eight enterprises that represent the current behavior of the households in the study area. These enterprises were further classified into four groups: (1) agricultural enterprises (crop production and livestock production), (2) agro-allied enterprises (agricultural produce processing), (3) extractive enterprises (fuelwood/charcoal and food gathering/hunting) and (4) off-farm enterprises (trading, other non-farm activities and salaried jobs). This is because improved agricultural technologies are often developed to address the problems related to these four groups of enterprises. For instance, technologies to increase crop and livestock production and productivity are often formulated. Another important reason for classifying the enterprises into the four groups is to clearly assess the gender differences in labor allocations to the enterprise (s) within each group. This will have great implications on activities and projects aimed at improving the welfare of households targeted with different enterprises.

Sample selection and survey: A stratified two-stage random sampling method was used to select 322 farm households, 161 each from the two agroecological zones. The first stage involved grouping villages into (i) those with primarily upland activities and (ii) those where farmers have upland fields and some access to *fadamas* (lowland fields). Uplands and *fadamas* are the major landforms on which agricultural production takes place in the study area. Kaduna State Agricultural Development Program (KADP) and Kano State Agricultural and Rural Development Authority (KNARDA) provided the sampling frames (list of villages). Two villages each were randomly selected from each of the lists of villages, making a total

of eight villages (four from each zone, two from each landform). In the second stage, eight different sampling frames were constructed of all the households in each of the selected villages. A household is a group of persons living, working and eating together and having a distinct head. From each list, 40 households (or 41 in two villages) were selected, making a total of 322 households. The heads of selected households, assisted by the other available household members, were interviewed using a structured questionnaire. Labor allocation to enterprises was determined by the use of the proportional piling method. Data were collected on labor allocation by gender (Household head, Spouse, Male children and Female children) on the various enterprises. Enumerators recorded the applicable labor allocations after the household head and the other household members who participated in the interview agreed on labor allocation by members of the household aged 10 years and above (cut-off age for this study).

Computational model specification: Following Awange [7] and Awange *et al.* [8] (Table 3 and Fig. 1), we computed the Weighted Arithmetic Means (WAM) and the Percent Labor Allocations (PLA) to each enterprise using steps 1 and 2 below.

Step 1:
$$WAM = \frac{X_1 P_1 + X_2 P_2 + ... + X_n P_n}{P_1 + P_2 + ... + P_n}$$

where $\{X_1, X_2, ..., X_n\}$ are enterprises and $\{P_1, P_2, ..., P_n\}$ are weights given by:

Weight
$$(P_i) = \frac{Enterprise}{Total\ of\ enterprises\ (100)}$$

Example: We consider as an example the enterprises 1, 2, 3, ..., n on which an individual's total labor allocation must sum up to 100%. If this individual's labor allocation is say 60% to enterprise 1, 20% to enterprise 2, 0% to enterprise 3, ... and 20% to enterprise n, then the weights (P_i) will be

$P_1 = \dfrac{60}{100}$ or 0.6 for enterprise 1, $P_2 = \dfrac{20}{100}$ or 0.2 for enterprise 2,

$P_1 = \dfrac{0}{100}$ or 0.0 for enterprise 3, ..., $P_n = \dfrac{20}{100}$ or 0.2 for enterprise n.

Step 2: The weights are multiplied by the original labor allocation and summed across all observations to obtain the total weighted values for each enterprise. The WAM was calculated by dividing the summed total weighted values (across all observations) for each enterprise by the total of weights for each enterprise across all observations.

The PLA to an enterprise was computed by dividing the product of WAM and sum of weights for the enterprise ($\bar{x}iwi$) by the sum of the products of the WAM and total weights ($S\bar{x}iwi$) for all the enterprises. This is expressed as a percentage by multiplying by 100.

The sum of total weighted arithmetic means, ($\Sigma\bar{x}iwi$), is calculated as follows:

$$\Sigma\bar{x}iwi = \bar{x}1w1 + \bar{x}2w2 + ... + \bar{x}nwn$$

Table 1: Example on how to compute PLA (Per cent Labor Allocation) to enterprises

Enterprise	Arithmetic mean ($\bar{x}i$)	Sum of weights (wi)	$\bar{x}iwi$	PLA= $\left(\dfrac{\overline{x}1w1}{S\overline{x}iwi} *100 \right)$
1	61.30	2.3	141	82.0
2	20.0	0.6	12	7.0
3	0.0	0.0	0	0.0
4	15.0	0.4	6	3.5
5	0.0	0.0	0	0.0
6	20.0	0.2	4	2.3
7	18.0	0.5	9	5.2
8	0.0	0.0	0	0.0
			172	100.0

Source: Hypothetical example

where, $\bar{x}1, \bar{x}2,...\bar{x}n$ are the weighted arithmetic means of different enterprises and w1, w2,...wn are the corresponding total weights of the weighting factors for the different enterprises. Therefore,

$$PLA=\left(\frac{\overline{x}1w1}{S\overline{x}iwi} *100 \right)$$

Example: See the labor allocation to enterprises one to eight in column 1 of Table 1. If the content of the next three columns are as follows: Arithmetic Mean for each enterprise ($\bar{x}i$) for column II, the Sum of Weights for each enterprise (w_i) for column III and the product of columns II and III ($\bar{x}iwi$) for column IV, then we can calculate the PLA for each enterprise (column V) using the formula:

$$PLA=\left(\frac{\overline{x}1w1}{S\overline{x}iwi} *100 \right)$$

RESULTS

Prevalence of the enterprises: Table 2 shows that for the men (household heads[6] and male children, including other male relations living in the household), crop production was the most popular of the enterprises evaluated. It was distantly followed by livestock production while other non-farm activities ranked third. For the women (spouses[7] and female children, including other female relations living in the household), agricultural produce processing was the most popular while livestock production ranked second. A major difference between the women (i.e., wives on one hand and female children on the other) is that while other non-farm activities ranked third among the spouses, crop production ranked third among the female children.

Across gender, the four most important enterprises (in terms of presence) among the households were crop production, livestock production, agricultural produce processing and other non-farm activities. The least important enterprises were salaried jobs, food gathering and hunting, fuelwood and charcoal activities and trading.

Labor allocation pattern across the survey area: Results of the labor allocation pattern across the study area are presented in Table 3. The household head allocated most (80.6%) of his labor to crop production., giving insignificant attention to all other enterprises (including livestock production and other non-farm activities that appeared to be popular

Table 2: Households involved in different enterprises as % of eligible[a] households by gender in the savannas of northern Nigeria

Enterprise	Household head [b]	Spouse [c]	Male children [d]	Female children [e]
Crop production	89.4	19.3	98.7	46.4
Livestock production	48.0	40.5	65.2	74.5
Agricultural produce processing	12.8	50.2	17.8	78.2
Fuelwood and charcoal activities	23.1	15.6	29.6	40.9
Gathering and hunting	10.0	0.7	14.8	4.5
Trading	33.0	23.3	29.6	31.8
Other non-farm activities	43.9	23.9	54.3	40.0
Salaried job	4.0	0.0	6.1	0.9

[a]Has household members in respective gender categories

[b]321 survey households or 99.7% (male-headed) were eligible

[c]301 households or 93.5% were eligible (had spouses, females in all cases)

[d]230 households or 71.4% were eligible (had male children aged 10 years +)

[e]110 households or 34.2% were eligible (had female children aged 10 years +)

Source: Household survey-February/March and September/October 2002

Table 3: Labor allocation (%) to enterprises by gender in the savannas of northern Nigeria

Enterprise	Household head [a]	Spouse [b]	Male children [c]	Female children [d]
Crop production	80.562	22.708	71.123	31.820
Livestock production	4.430	6.194	7.738	11.917
Agricultural produce processing	0.747	56.696	1.445	36.280
Fuelwood and charcoal activities	2.445	3.559	1.316	3.787
Gathering and hunting	0.913	0.003	0.481	0.176
Trading	3.000	5.541	2.208	2.401
Other non-farm activities	6.063	5.299	13.669	13.615
Salaried job	1.838	0.000	2.018	0.004

[a]All survey households were male-headed except one

[b]Spouses were females in all cases

[c]Including other male relations living in the household

[d]Including other female relations living in the household

Source: Household survey-February/March and September/October 2002

among heads of the households based on the data in Table 2). The male children who allocated about 71.1% labor to crop production displayed a similar pattern. The highest labor allocation (56.7%) by the spouse was to produce processing, surprisingly followed by crop production (22.7%) instead of livestock production that appeared to be the second most popular enterprise or other non-farm activities (that ranked third among the spouses) (Table 2). The female children displayed a similar but slightly different pattern by allocating the highest quantity (36.2%) of labor to produce processing, followed by crop production (31.8%) that ranked the third most popular enterprise (Table 2). However, other non-farm activities that were ranked the second most popular (Table 2) were actually allocated only 13.6% of the female children's labor.

Labor allocation pattern by agro-ecological zone: The data from the Guinea savanna zone (Table 4) show that household heads allocated most of their labor (82.6%) to crop production. The male children showed a similar but slightly different pattern and allocated 74.1% of their labor to crop production and about 10.2% to livestock production. The spouse and female children had a similar labor allocation pattern in this zone, allocating 59.8% (spouse) and 65.2% (female children) to crop production, 19.2% (spouse) and 18.2% (female children) to processing and 9.3% (spouse) and 11.4% (female children) to livestock production.

Table 4: Labor allocation (%) to enterprises by gender in the Guinea savanna zone [a] of northern Nigeria

Enterprise	Household head [b]	Spouse [c]	Male children [d]	Female children [e]
Crop production	82.627	59.752	74.115	65.165
Livestock production	3.978	9.270	10.317	11.403
Agricultural produce processing	1.041	19.218	2.206	18.207
Fuelwood and charcoal activities	4.778	5.279	1.902	3.924
Gathering and hunting	1.596	0.000	0.704	0.076
Trading	2.866	6.364	0.452	0.776
Other non-farm activities	2.004	0.118	9.759	0.449
Salaried job	1.110	0.000	0.545	0.000

[a]Mostly in Kaduna administrative state

[b]All survey households were male-headed except one

[c]Spouses were females in all cases

[d]Including other male relations living in the household

[e]Including other female relations living in the household

Source: Household survey-February/March and September/October 2002

Table 5: Labor allocation (%) to enterprises by gender in the Sudan savanna zone [a] of northern Nigeria

Enterprise	Household head [b]	Spouse [c]	Male children [d]	Female children [e]
Crop production	78.714	0.076	68.210	0.668
Livestock production	4.835	4.316	5.227	12.397
Agricultural produce processing	0.484	79.593	0.704	53.165
Fuelwood and charcoal activities	0.359	2.509	0.745	3.659
Gathering and hunting	0.302	0.005	0.264	0.269
Trading	3.121	5.038	3.919	3.920
Other non-farm activities	9.695	8.464	17.478	25.915
Salaried job	2.490	0.000	3.453	0.009

[a]Mostly in Kano administrative state

[b]All survey households were male-headed

[c]Spouses were females in all cases

[d]Including other male relations living in the household

[e]Including other female relations living in the household

Source: Household survey-February/March and September/October 2002

Results from the Sudan savanna zone (Table 5) show a similar labor allocation pattern between the household head and the male children and between the spouse and the female children. Among the males, labor allocation was highest to crop production (78.7%, household head; 68.2%, male children), followed by other non-farm activities (9.7%, household head; 17.5%, male children). Among the women, labor allocation was highest to produce processing (79.6%, spouse; 53.2%, female children), followed by other non-farm activities (8.5%, spouse; 25.9%, female children). This result shows the increasing importance of other non-farm activities among children (male and female, Sudan savanna; male, Guinea savanna). This is a response to the increasingly harsh agricultural environment in the area, especially in the Sudan savanna that is much more prone to drought.

Labor allocation pattern by survey village: Table 6 presents labor allocation by the head of the household for the survey villages. Household heads allocated over 90% of their labor to crop production in three villages (Yelwa Danzial, Doka, Galma), between 80 and 90% in two villages (Runa, Muriga) and less than 80% in three villages (Matsirga, Wailare, Dan Hassan). In the villages where household heads allocated less than 80% of their labor to crop production, the other

Table 6: Household head's labor allocation (%) to enterprises by survey village in the savannas of northern Nigeria

	Guinea savanna [a]				Sudan savanna [b]			
Enterprise	Muriga	Doka	Galma	Matsirga	Yelwa Danzial	Dan Hassan	Wailare	Runa
Crop production	87.375	92.209	96.279	51.995	91.673	72.826	63.886	82.032
Livestock production	3.675	2.224	0	9.735	1.325	4.510	4.536	9.572
Agric. produce processing	0	0	0	4.871	0	2.409	0.012	0.140
Fuelwood/charcoal	1.385	0.097	1.452	19.087	0	1.908	0.024	0
Gathering and hunting	0.092	2.289	0	3.999	0	0	1.198	0
Trading	2.454	1.956	2.269	5.232	2.824	5.318	3.522	1.495
Other non-farm activities	2.535	0.698	0	4.468	4.178	13.029	19.091	4.648
Salaried jobs	2.484	0.527	0	0.613	0	0	7.731	2.114

[a]Mostly in Kaduna administrative state

[b]Mostly in Kano administrative state

Source: Household survey-February/March and September/October 2002

Table 7: Spouse's labor allocation (%) to enterprises by survey village in the savannas of northern Nigeria

	Guinea savanna [a]				Sudan savanna [b]			
Enterprise	Muriga	Doka	Galma	Matsirga	Yelwa Danzial	Dan Hassan	Wailare	Runa
Crop production	65.789	93.496	-	19.401	0.187	0.117	0	0
Livestock production	0	0.757	-	19.608	4.929	14.221	2.397	0
Agric. produce processing	0	1.832	-	40.339	90.483	57.895	70.817	92.308
Fuelwood/charcoal	23.684	1.283	-	9.662	0	18.825	0.011	0
Gathering and hunting	0	0	-	0	0	0.040	0	0
Trading	0	2.593	-	10.990	1.542	1.818	12.243	0
Other non-farm activities	10.526	0.037	-	0	2.859	7.083	14.532	7.692
Salaried jobs	0	0	-	0	0	0	0	0

[a]Mostly in Kaduna administrative state

[b]Mostly in Kano administrative state

Source: Household survey-February/March and September/October 2002

enterprises that assumed labor allocation importance were fuelwood/charcoal activities (19.1%) and livestock production (9.7%) for Matsirga, other non-farm activities for Wailare (19.1%) and Dan Hassan (13.0%). The household heads did not allocate labor to processing in four villages (Muriga, Doka, Galma, Guinea savanna; Yelwa Danzial, Sudan savanna), food gathering and hunting in four villages (Galma, Guinea savanna; Yelwa Danzial, Dan Hassan, Runa, Sudan savanna), salaried job in three villages (Galma, Yelwa Danzial, Dan Hassan), fuelwood/charcoal activities in two villages (Yelwa Danzial, Runa), livestock production and other non-farm activities in one village (Galma). On the contrary, the household heads allocated some labor to crop production and trading in all villages, again demonstrating the importance of these two enterprises among the heads of households. However, only 1.5 to 5.3% of labor was allocated to trading.

The result of labor allocation by the spouse (Table 7) shows no indication that the spouses from the Galma village contributed labor to any enterprise. However, for the remaining villages, the spouse allocated a reasonable quantity of labor to crop production in only three villages (Doka, Muriga, Matsirga), all from the Guinea savanna. The spouses allocated most of their labor to processing in five villages (Matsirga, in Guinea savanna; Dan Hassan, Wailare, Yelwa Danzial and Runa, in Sudan savanna). The other enterprises that received over 10% labor allocation by the spouse in selected villages were livestock production, fuelwood/charcoal activities, trading and other non-farm activities. No spouse allocated labor to salaried a job across the villages and to food gathering/hunting in seven villages. This was also true

Table 8: Male children's [a] labor allocation (%) to enterprises by survey village in the savannas of northern Nigeria

Enterprise	Guinea savanna[b]				Sudan savanna[c]			
	Muriga	Doka	Galma	Matsirga	Yelwa Danzial	Dan Hassan	Wailare	Runa
Crop production	41.633	88.736	93.256	63.761	63.756	68.983	56.755	78.501
Livestock production	1.939	8.895	1.285	23.256	0.350	5.423	6.675	10.255
Agric. produce processing	0.114	0.016	0	7.750	0	2.122	0.119	0.631
Fuelwood/charcoal	2.116	0.013	3.077	3.423	0	2.106	0.389	0.660
Gathering and hunting	0	1.593	0	0.469	0	0.443	0.149	0.488
Trading	0.330	0.444	0.268	0.657	3.689	3.348	1.207	5.998
Other non-farm activities	51.021	0.301	2.113	0.558	31.531	9.416	26.987	2.733
Salaried jobs	2.846	0.003	0	0.126	0.674	8.159	7.718	0.733

[a]Including other male relations (aged 10 years and above) living in the household

[b]Mostly in Kaduna administrative state

[c]Mostly in Kano administrative state

Source: Household survey-February/March and September/October 2002

Table 9: Female children's [a] labor allocation (%) to enterprises by survey village in the savannas of northern Nigeria

Enterprise	Guinea savanna[b]				Sudan savanna[c]			
	Muriga	Doka	Galma	Matsirga	Yelwa Danzial	Dan Hassan	Wailare	Runa
Crop production	63.291	86.347	-	17.643	0.432	2.338	0	0.053
Livestock production	0	8.941	-	17.480	5.171	19.982	4.608	30.625
Agric. produce processing	0	2.230	-	54.987	81.903	48.164	22.009	61.422
Fuelwood/charcoal	5.696	1.739	-	8.751	0	15.333	0	1.461
Gathering and hunting	0	0.111	-	0	0	0	0	1.675
Trading	0	0.631	-	1.140	4.321	5.539	2.662	3.218
Other non-farm activities	31.013	0	-	0	8.174	8.644	70.693	1.546
Salaried jobs	0	0	-	0	0	0	0.029	0

[a]Including other female relations (aged 10 years and above) living in the household

[b]Mostly in Kaduna administrative state

[c]Mostly in Kano administrative state

Source: Household survey-February/March and September/October 2002

in three villages each of crop production, livestock production, fuelwood/charcoal activities and trading and in two villages each of produce processing and other non-farm activities. None of the enterprises was universally embraced across the villages by the spouse.

Labor allocation by the male children (Table 8) shows that in all villages except Muriga, male children's labor allocation was highest to crop production, ranging from 56.8% in Wailare to 93.3% in Galma. However, in Muriga, the highest allocation of male children's labor was to other non-farm activities (51.0%) with crop production (41.6%) ranking second. Also, other non-farm activities were allocated the second highest quantity of male children's labor in three other villages (Dan Hassan, Wailare and Yelwa Danzial). In three (Doka, Runa and Matsirga) out of the remaining five villages, livestock production was accorded the second highest quantity of male children's labor allocation. Table 8 also shows that four enterprises (crop production, livestock production, trading and other non-farm activities) had some male children's labor allocation in all the villages. Of the remaining four enterprises, fuelwood/charcoal activities and salaried job had some male children's labor allocated to it in seven out of the eight survey villages, produce processing in six of the survey villages while food gathering and hunting had some male children's labor allocated to it in five villages. In summary, Table 8 has demonstrated the emerging significance of male children's labor in the diversification of the means of livelihood.

The results of labor allocation by female children (Table 9) show no indication that the female children in Galma contributed labor to any enterprise. However, for the other villages, female children allocated a large quantity of labor to

crop production in the same three villages (Doka, Muriga, Matsirga) where the labor allocation of the spouses to crop production was also highest. The female children allocated most of their labor to processing in four villages (Matsirga, in Guinea savanna; Dan Hassan, Runa, Yelwa Danzial, in Sudan savanna). In Wailare, female children allocated about 70.7% labor to other non-farm activities. The other enterprises that received over 10% of female children's labor allocation were livestock production (in Muriga, Dan Hassan and Runa), produce processing (in Wailare), fuelwood/charcoal activities (in Dan Hassan) and other non-farm activities (in Muriga). The results from the female children's labor allocation follow a pattern similar to the allocation by the spouses except for trading that was not allocated up to 10% of labor by the female children in any village. The female children did not allocate any labor to: (i) salaried job in seven villages, (ii) food gathering/hunting in six villages, (iii) fuelwood/charcoal activities and other non-farm activities in three villages each and (iv) crop production, livestock production, agricultural produce processing and trading in two villages each. So, like the spouses, female children universally embraced no enterprise. In summary, the labor allocation pattern of the female children followed a pattern similar to the allocation by the spouse in most of the study area.

DISCUSSIONS AND CONCLUSIONS

A combination of the data presented in Table 2 to 9 indicates a similarity in the labor allocation pattern of the men (household head and male children) and also of the women (spouse and female children). However, while men's labor was allocated primarily to crop production, women's labor was allocated primarily to agricultural produce processing.

The differential pattern in labor allocation between men and women indicates the existence of intra-household division of labor along sex lines-a situation that was clearer in the Sudan savanna (dominated by Muslims whose religion constrains women's involvement in crop production, restricting them mostly to produce processing, often carried out at home) than in the Guinea savanna (with significant number of Christians) where women allocated more of their labor to crop production than to agricultural produce processing. This implies that crop production and produce processing are more or less gender-neutral in the Guinea savanna. On the contrary, both crop production and produce processing are gender-sensitive in the Sudan savanna.

Across the survey area, crop production ranks next to produce processing in the allocation of women's labor. Our result with respect to food processing is consistent with the findings of Nweke *et al.* [4] that cassava processing was carried out mostly by women in 76% of the COSCA villages. Nweke *et al.* [4], however, noted that men increase their labor input in cassava processing in areas where cassava is produced mainly for cash and for urban consumers. In the coming contribution, we will show the critical correlation of labor allocation to the enterprises along gender lines and its implications for development and sustainability.

The labor of the household head was the most concentrated on crop production. This was followed by the labor of the male children, also on crop production. This high concentration of men's labor on crop production is strong evidence that men, not women (as some earlier researches tend to indicate) play the dominant role in agricultural production in the study area. Our findings are consistent with the findings of Spencer [2] and Nweke *et al.* [4] that men play an important role in agricultural production in Africa. However, our result does not support a recent report by the World Bank that African women perform 90% of the work of hoeing and weeding [9] and earlier researches by Boserup [1] and Snyder [3]. These results that have placed the agricultural role of women in Africa above that of men represent generalizations since our results and those of Spencer [2] and Nweke *et al.* [2002] have indicated important exceptions.

Spouse's labor allocation to crop production varies from 0% in Galma, Runa and Wailare villages to as high as 93.5% in Doka (Table 7). Similarly, female children's labor allocation to crop production ranges from 0% in Galma and Wailare to as high as 86.3% in Doka village) (Table 9). These show important differences in labor allocation to crop production by women.

Although men dominate in labor contribution to crop production, our result highlights the crucial role of women in food processing in most of the villages, especially in the Sudan savanna.

The non-or very little allocation of both men's (especially household head's) and women's labor to other enterprises, aside from crop production and produce processing (Table 3 and also Table 6 to 9 for little differences for different gender) has revealed that the issues involved in these enterprises (even though some are vital to households) are not yet considered important by farmers. The low labor contribution to livestock production must have contributed to the weak crop-livestock integration and limited impact in the study area [10, 220-221] and underscores the need for policy incentives to reverse the trend and advance sustainable agricultural production through the mutual benefits of crops and livestock from crop-livestock integration. The low investment of labor on the extractive activities (fuelwood/charcoal and gathering/hunting) is a positive behavior and increased efforts are needed to continue to dissuade households from extractive tendencies that degrade the environment. Finally, the low labor allocation to non-farm activities (trading, other non-farm activities and salaried job) implies that diversification outside the agricultural sector, often recommended to reduce pressure on land, is either not taking place or taking place only at insignificant rates. Considering the farm resource pressure and the high agricultural production risk (due to drought, diseases/pests, etc.) that characterize the farming systems of the savannas of northern Nigeria, policy interventions are clearly needed to encourage more off-farm diversification.

The pattern of labor allocation also has implications on future technology development, targeting and technology adoption. Improved agricultural technologies developed on the enterprises to which households allocate their scarce labor and properly targeted would have a higher probability of adoption than technologies that focus on issues not yet considered important by the target group, at least through their labor allocation behavior.

The male children's labor was the most diversified (Table 8). This gives hope for the future regarding the need to diversify the income base of farmers in sub-Saharan Africa to reduce pressure on farmland, increase household food security and protect the environment. Since agricultural produce processing is a popular and gender-sensitive enterprise, improved technologies related to produce processing must be targeted to women to enhance widespread adoption and impact.

Based on percentage labor allocation, we can conclude that, among the enterprise groups, only agricultural enterprises (especially crop production) and agro-allied enterprises (represented by agricultural produce processing) are currently important. Off-farm enterprises (trading, etc.) are still at developmental stages even though they are crucial in relieving the pressure on agricultural resources. The low allocation of labor on extractive enterprises is good for the environment and needs further promotion.

LIMITATIONS OF THIS STUDY

Available data were sufficient only for the determination of labor allocation to enterprises by gender without insight on labor productivity that is equally important. Further research is needed on labor productivity (by gender) in the enterprises since a critical policy question is the returns to an hour of labor rather than number of hours worked.

ACKNOWLEDGEMENT

Notes: 1A pile of small stones, usually 20 in number (but could be more if necessary), was used. The stones were poured on the ground and farmers used them to apportion how they allocate their labor to the eight enterprises evaluated. Counting and recording of the final proportional piling was undertaken only after household head and other household members had adjusted the number of stones in the piles in whichever way they felt portrayed the situation for different inmates of the household.

[2]All survey households were male-headed except one
[3]Spouses were females in all cases
[4]Including other male relations or non-relations living in the household
[5]Including other female relations or non-relations living in the household
[6]Male in all cases except one (regarded ineligible in this analysis)
[7]Female in all households that had spouse (the eligible cases)

REFERENCES

1. Boserup, E., 1970. Women's role in economic development. New York: St. Martin's Press.
2. Spencer, D.S.C., 1976. African women in agricultural development: A case study in Sierra Leone. American Overseas Liaison Committee Paper No. 9. Washington, DC: American Council on Education.
3. Snyder, M., 1990. Women: Key to ending hunger: The Hunger Project Papers, No. 8. New York: Global Hunger Project.
4. Nweke, F.I., D.S.C. Spencer and J. Lynam, 2002. The cassava transformation: Africa's best-kept secret. East Lansing, USA, Michigan State University Press.
5. World Bank., 2001. World development report. Washington DC, World Bank.
6. IFAD (International Fund for Agricultural Development), 2001. Rural poverty report, 2001: The challenge of ending rural poverty. Oxford University Press, for the International Fund for Agricultural Development.
7. Awange, J.L., 2002. Grobner Bases, Multipolynomial Resultants and the Gauss-Jacobi Combinatorial Algorithms-Adjustment of Nonlinear GPS/LPS Observations. Technical Reports. Department of Geodesy and Geoinformatics, Universitaet Stuttgart, Germany.
8. Awange, J.L., Y. Fukuda, S. Takemoto, I.L. Ateya and E.W. Grafarend, 2003. Ranging algebraically with more observations than unknowns. Earth Planet Space, 55: 387-394.
9. World Bank, 2000. Women: Key to African development. *News Release* No: 2000/340/AFR. Washington DC, World Bank.
10. Chianu, J.N. and H. Tsujii, 2004. Missing links in sustainable food production in West Africa: Case of the savannas of northern Nigeria. Sustainable Development 12: 212-222.