Modeling District-Level Socioeconomic Linkages and Growth: Towards Sustainable Natural Resource Management in Agricultural and Pastoral Systems Under Environmental Stress and Conflict in the Niger Delta Region of Mali [*]

by

Daniel P. Kaboré, Breima Traoré, Daniel B. Taylor, Peter Wyeth
Michael K. Bertelsen, and David Holland [**]

American Agricultural Economics Association Annual Meeting,

July 30-August 2, 2000

Selected Paper

[*] Research supported by USAID through the Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANRM CRSP), Contract no. PCE-00-98-0019-00. All opinions expressed are those of the authors.

[**] Graduate Student, Virginia Tech; Ecologist, Institut d'Economie Rurale; Professor, Virginia Tech; Assistant Professor, Washington State University; Program Director and Coordinator NRM Inter CRSP – Office of International Research and Development—Virginia Tech; and Professor, Washington State University. Contact: Daniel B. Taylor, Department of Agricultural and Applied Economics, Virginia Tech, Blacksburg, Virginia, 24061. Telephone: 540-231-5032, Email: taylord@vt.edu.

Modeling District-Level Socioeconomic Linkages and Growth: Towards Sustainable Natural Resource Management in Agricultural and Pastoral Systems Under Environmental Stress and Conflict in the Niger Delta Region of Mali

Introduction and Problem Statement

During the last few decades, climate variability has combined with human activities to contribute to accelerated natural resource degradation in West Africa. Traditional production systems have become progressively more unsustainable as higher demographic pressure, increasing poverty, and greater food insecurity promote more intensive use of scarce natural resources. The resulting increased competition for natural resources has given rise to more conflict (open or potential) between stakeholders.

In Mali, and particularly in Mali's delta region, natural resource-based conflict among farmers, agro-pastoralists and pastoralists is becoming much more common. The Niger delta region (about 80,000 sq. km) has in the past been a traditional resource user sharing space with an abundant natural resource endowment (cropping and grazing land and water) for farmers, pastoralists and fishermen from within and outside of the region. Progressive resource depletion has compelled these stakeholders to give up or to modify their traditional activities, which they historically specialized in, in favor of new practices in a risk-reducing attempt to cope with increasing subsistence difficulties. These changing strategies have increased other risks including the chance of more frequent and open conflicts.

Specifically in the study area of the Malian Commune of Madiama farmers (Malinke, Dogon, Samogo), herders (Fulanis - traditional herders originally from Mali or Burkina Faso) and fishermen (Bozos) are in permanent or semi-permanent residence (Sada Sy, 1994). In the past, most of the land in the commune was flooded by the end of the rainy season, greatly benefiting agriculture (rice, sorghum) due to the enhancement of soil fertility and provision of adequate moisture for plants. The government, in its efforts to promote rice cropping, improved the land along the river (casiers), which is the most likely to retain water for wetland recessional rice cropping. Fishermen were able to fish nearly the whole year since water in the river never reached a level preventing it (Daget, 1994). Fulani herdsmen followed the rains south during the rainy season and from harvest time to early in the cropping season moved north to take advantage of crop residues (rice in the "casiers", sorghum in farmers' fields), of the bourgou (*Echinocloa Stignina*--a water plant consumed by cattle) and the pasture along the river when the water level was low. Farmers cultivated their crops during the rainy season and raised animals.

Their cattle were mostly entrusted to Fulanis who removed them from the area during the rainy season. During the dry season, farmers benefited from manure deposited during the herds' stay on their fields. A barter system usually existed between the different classes of resource users: farmers trading cereals for milk or manure from Fulanis who gained water and pasture access while the Bozos traded fish for the products of the others.

This pattern of natural resource use began to change a few decades ago as a consequence of climate variability and human activities that combined to progressively deplete the resource base. The Niger River as well as one of its main tributaries, the Bani River, supplies less and less water each year because of decreasing rainfall. The government "casiers" operated by farmers often experience severe water shortages that prevent rice cropping. Crop yields have decreased and farmers have had to expand cultivated lands not only to compensate for the drastic yield decline, but also to increase total production in an attempt to keep pace with the increasing population. This extensive agriculture is made possible by the availability of animal traction (oxen, horses, and donkeys) but has, in turn, resulted in the virtual disappearance of fallow, the traditional means of resting land and restoring soil fertility.

Over time, unsuccessful fishermen have become farmers (Lae et al., 1994), increasing the pressure on agricultural resources, especially cropland. Herders also have progressively had more difficulty finding grazing land for animals during the cropping season along the river and/or on the farmers' fields. In addition, they have had less chance to prevent crop damage caused by their animals because of larger fields developing along their migration routes. The depleted natural resource base has resulted in high rates of livestock mortality during drought with little opportunity for herd reconstitution. For these reasons, many herders have also become farmers keeping all of their livestock manure for themselves. Similarly, bad crop yields over time have led farmers to a diversification strategy adding livestock that remains on farm year round to their enterprise mix. As a result of this evolutionary process, four categories of natural resource users have now evolved:

(a) Farmers: their main activity still remains farming characterized by an extensive production system;

(b) Agro-pastoralists: they raise animals along with their farming activities in a risk reduction strategy. Their former traditional activity was either herding or farming;

(c) Sedentary pastoralists: their herds are of bigger size than agro-pastoralists and are grazing within and outside of the commune but the whole household does not migrate and they usually carry out some farming activities;

(d) (d) Transhumant pastoralists: they are moving inside and/or outside of the commune seeking water and pasture for the animals. The transhumance schedule consists of moving around the Niger River and other water sources during the dry season and moving to the south during the rainy season.

Given these adjustments, there appears to be more sources of open or potential conflicts. More and more farmers are using the same land areas for extensive cropping systems; this leads to the exhaustion of the soil and increases chances of conflict with other farmers over time. Our preliminary data from the study area indicate that a large amount of total available land is being used for crop production. That means less land left for herding, a land-extensive activity in the traditional system. Despite this, herders continue to represent a high proportion of the population and this fact explains the prevalence of conflicts between farmers and herders, often deadly, due to crop damage by animals or over the use of the *bourgou*. Conflicts over this latter develop when, for example, farmers want to harvest and store the *bourgou* to feed their animals later in the dry season while the transhumant herders prefer to graze animals *in situ.*

Although it is hypothesized that economic growth could reduce the prevalence of such conflicts, pro-growth policy and investment decisions will require a comprehensive understanding of the linkages within the local economies of the region if they are to positively impact targeted groups of natural resource users. The objective of this study is to model these linkages and analyze their impacts on the region. Using an extensive data set collected in the study area this paper develops a Social Accounting Matrix model for the Madiama commune within the Mopti region in northern Mali, in order to better understand and analyze: (a) the linkages among different stakeholders and institutions, (b) growth interactions between sectors in the commune, and (c) the impact of potential conflict mitigation policies. Policy scenarios are evaluated in order to provide information to the commune, which is the administrative unit that is empowered to make natural resource management decisions.

Methods of Data Collection

The commune was chosen as a relevant geographical survey unit and the Madiama commune was selected by the SANREM CRSP (Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program) in consultation with NGO (Non Government Organization) partners and IER (*Institut d'Economic Rurale*) collaborators. Focusing at this level will allow commune level decision-makers to directly use the results of the study. This selection of the study area was made during a workshop in Bamako, Mali, attended by local institutions as well as US university representatives. A two-week Participatory Landscape/Lifescape Appraisal (PLLA) carried out in February 1999 in Madiama commune gave preliminary data that were used to select study villages for a follow-up structural survey. In depth structural surveys were carried out in February-March and in September 1999.[1]

Information from the PLLA as well as secondary data (Mali 1996 Census data) was used to select study villages. Five villages out of the ten villages were selected: Madiama, the headquarters of the commune; Nerokoro, a pastoralist village; Promani, a village of sedentary and transhumant pastoralists and farmers; Tombonkan, a farmers' village; and Tatia-Nouna, a village of farmers and agro-pastoralists. The list of the households in the commune was obtained for each village from the 1996 census data available from government offices (Sofara, 1996). The sample size was 120 households randomly selected representing about 10% of the commune households in 1996. The distribution of the four groups of stakeholders in the sample is presented in Table 1.

A meeting was held in each village with the farmers/herders in order to explain the objectives of the study and to encourage them to be patient and open to the questions. The active participation of a Fulani community leader from Nerekoro was particularly helpful in soliciting the participation of the transhumant pastoralists while the Chief of Tatia-Nouna was very supportive in gaining farmer confidence. Individuals to sample were randomly selected from the village list and the stakeholder group that they belonged to was determined by the consensus at the meeting. Of course, transhumant pastoralists were not present at the meeting but their current location was determined, and someone from the village was designated to inform them of our future visit to survey them.

Two types of data were collected. The first type was related to household characteristics, production and consumption, factors exchanged (labor, equipment, land, money).

[1] At the time of the survey the exchange rate was $1.00 US = 600 FCFA.

Table 1: Sample distribution by activity and village, Madiama commune Mopti region, Mali, 1999

	Group by Main Activity				
		Agro-	Pastoralists		
Village	Farmers	pastoralists	Sedentary	Transhumant	Total
Madiama	12	20	0	0	32
Promani	08	05	10	0	23
Tombonkan	09	01	0	0	10
Tatia-Nouna	14	06	04	0	24
Nerekoro	0	01	09	21	31
TOTAL	43 (36)	33 (27)	23 (19)	21 (18)	120 (100)

In parentheses are percentages of the sample size

Origin and source of factors exchanged were also recorded. The questionnaire was administered by four enumerators and two supervisors: a researcher from the *Institut d'Economie Rurale (I.E.R)* of Mopti (SANREM local partner) and a Virginia Tech graduate student. A two-day training session for both enumerators and the IER researcher was conducted in Madiama, in order to explain the objectives of the study, the SAM approach and the requirements of this kind of survey. The survey conducted in February-March 1999 took 3-4 hours for each respondent and was scheduled with a break after two hours or so, by the time of the Muslim prayer or lunchtime. Each enumerator was assigned to survey a maximum of two households per day in order to avoid weariness and therefore preserve data quality.

The second group of data was collected on microenterprise activities in the commune that are income generating activities such as food processing, handcrafts, retail trade, livestock trading, cereal trading and so forth. This data was collected in September 1999 on a sub-sample of 60 households drawn from the larger sample of 120 households .A pre-test was implemented with a few respondents in order to (a) correct/improve the questionnaire and (b) give enumerators survey experience. The training, the pre-test and the questionnaire improvement took one week.

A Method of Analysis: the Social Accounting Matrix

A social Accounting Matrix (SAM) model was developed to meet the objectives of the study. The SAM model is a modified input/output model that accounts for income effects and linkages of specific production activities among stakeholders. It is a very flexible and powerful tool that

adapts to study objectives, and therefore allows for analyzing economies in diverse social and cultural settings (Taylor et al. 1996). It has been used to analyze village economies (Subramanian, 1988) as well as for nationwide studies (Dorosh et al. 1991**,** Arndt et al. 1998; Pradham et al. 1999). Given its flexibility, the SAM can also be developed to address specific topics such as environmental issues (see Miller et al. 1985) or migration (Adelman et al. 1988).

The SAM is organized as an accounting matrix of modeler-selected endogenous and exogenous sectors' inflows and outflows. It is based on the assumption that production activities are endogenous and demand-driven. Exogenous variables might include, for example, government input subsidies or taxes. Shocks introduced into the commune economy as a result of changes in these variables produce changes in the circular flows of resources among sectors within the commune. The magnitudes of these impacts (multipliers) depend upon the strength of the linkages between the sectors. Similarly, the impact (and multipliers) of a decision made within the Madiama commune will be related to endogenous variables such as changing land distribution among sectors or changing transhumance scheduling through commune taxation of grazing lands. The natural resource management decision-makers of the commune will have the authority to make decisions about such variables in the future. Sector multipliers will be computed to summarize linkages and provide implications for policy scenarios. Analyzed multipliers are of two types:

- Shock multipliers measuring effects of variation in exogenous sectors on the commune; and,
- Leakage multipliers that summarize the induced effects on exogenous sectors of injections on endogenous institutions.

The multipliers provide important information to commune level decision-makers on the prospects for, and differential impacts of, economic growth on the various sectors. This has direct implications for who benefits and loses from policy changes and, by extension, how conflicting sectors benefit and how they might accordingly react to changes. The development of a SAM is a useful first step to begin such analyses because its flexible structure permits disaggregation into the relevant classes of interest (farmers, agro-pastoralists, sedentary pastoralists and transhumant pastoralists). It also contains information that is needed for developing Computable General Equilibrium models, which make explicit the functional relationships that overcome the linear drawbacks implicit in SAM models (Taylor et al., 1996).

The SAM structure

The sample and the sub-sample (for microentreprise) are composed of two strata: the "diversified group" and the "non-diversified group". The "non-diversified group" consists of the transhumants. The "diversified group" on the other hand is made of the other groups: farmers, agro-pastoralists and sedentary pastoralists. In order to expand the sample values to the whole commune, the appropriate expansion factors for each group were used. The expansion coefficient is equal to the inverse of the sample factor. For non-diversified group, which is exclusively taken from Nerokoro, the expansion coefficient is 90/21= 4.29; it is 1061/99=10.72 for the diversified group. The corresponding expansion coefficients for the microentreprise sub-sample are 10 (90/9) and 22.57 (1061/47) in the non-diversified and diversified groups. Expansion were used to expand any value from the sample (or sub-sample) to the universe (the whole commune) and the formula was:

$$\sum_i \sum_j g_i X_{ij}$$

where γ_i is the expansion coefficient for diversification group i (i=1,2) and X_{ij} the sample value for group i, stakeholder group j (j=1,2,3,4).The commune economy is organized into 31 accounts: 10 activities, 10 commodities, 4 factors, 5 institutions, one capital account and the rest of the world (see Appendix 1). Accounts have been aggregated[2]: activities/commodities consist of agricultural activities: cereals other than rice, that is millet, sorghum, maize, and fonio; rice; vegetables; and legumes; livestock; fish; natural resources; retail trade; durables; and government services (schools, dispensaries and so forth). Activities/commodities result from an aggregation of agricultural activities and their associated micro-entreprises. For example, the livestock activity includes not only livestock production, but also traded livestock while produced cereals and traded cereals are combined. Factors are broken out into land, capital (equipment), hired labor and family labor.

Institutions consist of farmers, agropastoralists, sedentary pastoralists, transhumants and government services. The capital account includes investment/saving in physical assets (agricultural and non-agricultural equipment) and livestock investment. In our initial SAM formulation, commodity rows include not only local production but also imports. Isolating production from imports in order to get information relative to the local economy is necessary.

[2] This aggregation was made to balance the SAM; a disaggregation will be needed later for an in-depth analysis.

Therefore in the SAM presented in this paper, all commodity rows are now import purged. This purging is carried out as follows: (1) compute for each commodity, the proportion (pc) of imports to the corresponding commodity column total. (2) Multiply each commodity value containing imports in the original SAM by (1-pc) to get values for locally produced commodity. The assumption is that all the entries in the commodity rows of the original SAM contain imports in the same proportion as the entries in the commodity columns. (3) Compute imports for each activity that are equal to the total of non-purged values (from the original SAM) minus the corresponding total of purged values. Doing so reduces by one half the number of activity/commodity columns and rows in the final SAM since we have a one-to-one correspondence between Activities and Commodities. Thus, the resulting SAM[3] (Table 2) does not include commodities any more, but 10 activities, 4 institutions and 4 factors (see Miller et al. 1985 for a discussion of the import purging approach). Table 2 illustrates the relative openness of Madiama commune's economy to the rest of the world. Institutions import 40% of their total expenditures while about 20% of their income is obtained from exports. Durables, government services, retail trade and natural resources are high import activities: 98%, 51%, 44% and 36% of their respective imports. Capital outflows amount to 18% of total imports. The SAM also reveals the bipolar characteristic of the communal economy with crops and livestock representing 50% and 34% of total production while retail trade accounts for 13%. As expected, family labor is the most important factor of production: over 96% of payments go to family labor and only about 3% to hired labor. Capital and land payments are marginal in this community. Crops contribute 56% to total factor payment or total value-added (30% for rice). The livestock sector provides 36% of total factor payment, while retail trade amounts to 7%.

Farmers' consumption expenditures represent 37% of their total expenditures while agropastoralists, sedentary pastoralists and transhumants respectively record 38%, 31% and 27% of their groups' total expenditures as consumption. Expenditures in agricultural products (rice and other cereals) and livestock combined amount to over 80% of consumption expenditures but exhibit an opposite pattern: the relative importance of livestock expenditures increases from farmers to transhumants while relative expenditures for agricultural products decrease. Expenditures for retail commodities amount to 4-8% while natural resources record marginal expenditures (less than 1%).

[3] This version of the SAM is the one used that we refer to, in this paper.

Investment in livestock represents 41% of total capital; agropastoralists' savings amount to 33% of total savings; sedentary pastoralists and transhumants equally share 26% while farmers' savings represent 15%. That difference in saving reflects the difference in livestock investment between the stakeholder groups.

In terms of saving rate, the SAM reveals that transhumants experience the highest saving rate (46% of total income) compared to farmers whose saving rate is 9% of their income. Agropastoralists and sedentary pastoralists have 17% and 24% saving rates, respectively.

Farmers' income represents 33% of total commune income while agropastoralists have 36%. Sedentary pastoralists and transhumants share 20% and 11% of total income. Over 70% of households' income is provided by family labor; 15-20% of labor income comes from outside the commune; the rest of the income mainly represents intra-group transfers (3-5%).

Input-output (Leontief) matrix and multipliers

A basic input-output assumption is that there exists a fixed proportional relationship between the input demand by sector i from sector j (Xij) and the output (Xj) of sector j that is: $Xij=aijXj$ where aij is the input-output coefficient. The equilibrium condition between total demand and total supply implies: $Xi = Xij + Fi$ where Xij is intermediate (input) demand and Fi final demand of the sector (exports, investment, and government services). Therefore, $aijXij + Fi = Xi$ or in matrix form, $AX + F = X$ and hence $X = (I-A)^{-1} F$ or $\Delta X=(I-A)^{-1}\Delta F$ for changes in final demand.

Taking the matrix of productive sectors and dividing each coefficient by the corresponding column total in the SAM we obtain the technical input-output coefficients matrix (A) (Sadoulet and De Janvry, 1995). Computing and inverting (I-A) give the input-output multipliers. Diagonal elements are own multipliers of the sector. Off diagonal ones are induced production while the totals are total production multipliers. Table 3 presents results for the Madiama commune. As expected, diagonal multipliers are close to one. Government services have the highest multiplier (1.514) indicating their positive impact on the local economy. The retail trade activity has a multiplier of 1.108. Among agricultural activities, rice exhibits the largest multiplier (1.052). Livestock and vegetables have a multiplier of 1.027. In terms of own multipliers, retail trade and rice activities have the highest at 1.060 and 1.052. For the induced production multipliers, governmental services have the highest potential impact at .514 followed

by retail trade (.048) and livestock (.024). These results illustrate the importance of crops (mainly rice and vegetables) and livestock as having a high impact on the commune economy in response to an increase in final demand. The natural resource sector also has a high potential in terms of its own multiplier.

SAM multipliers

The input-output table is extended to the other accounts. To obtain the SAM multipliers, accounts are portioned into endogenous and exogenous accounts. In our case, government, capital and the rest of the world are set as exogenous.[4] Dividing each value of the remaining endogenous variables by the corresponding column total, a matrix of coefficients C is obtained. For now, these coefficients are deemed to be the same as marginal expenditure shares in the activity, commodity and factor accounts.[5]

Shock multipliers: Inverting (I-C), we get the SAM multiplier matrix. (See Table 4). The multipliers give the impact of shocks on exogenous variables (exports capital and government services) on the structure of production, labor income and stakeholders' income (Sadoulet and De Janvry, 1995). It should be noted at the outset that SAM multipliers are larger than corresponding input-output multipliers, confirming the importance of expanding the input-output framework to the SAM by taking into account demand linkages due to value-added and incomes.

Apart from governmental services, agricultural products (rice, other cereals, legumes and vegetables) are high impact sectors with multipliers ranging from 1.58 to 1.63; rice is the crop recording the highest multiplier (1.63). These agricultural commodity multipliers can attribute about .18 of their magnitude to livestock. Livestock has a comparable multiplier to these agricultural commodities, 1.56 of which .27 is due to crops (rice and other cereals combined). Therefore there relatively high linkages exist between livestock and crop activities, particularly with rice. Similarly, a unit increase in crop activity final demand reveals a strong linkage with total factors of 1.48 on average. Retail trade, crops and livestock have a high potential impact on stakeholders' income with multipliers ranging from 1.46 (for livestock) to about 1.56 on average for crops and .85 for retail trade. Income increase is highest for agropastoralists (.57); it declines for farmers (.52) and sedentary pastoralists (about .30). It is the least strong for transhumants (about .15). The same pattern is observed for natural resources from .31 for agropastoralists, .28

[4] Multiplier values are sensitive to chosen exogenous variables.
[5] The possibility of the marginal and average expenditure shares being different will be examined as this preliminary research is refined.

for farmers, .17 and .09 for sedentary and transhumants pastoralists respectively. As for the income impact, with a multiplier of 1.66, a unit increase in agropastoralists income leads to the highest impact on the economy. A one-unit increase in agropastoralists' income has an impact of .63 on activities. An equivalent change leads to an impact of .62 for farmers, .53 for sedentary pastoralists and .44 for transhumants. In each case, a large part of the impact is accountable to livestock. The impact of livestock is more prominent for sedentary pastoralists and transhumants at about .26 versus .15 for farmers and agropastoralists. On stakeholder groups' income, we have the same pattern: 1.66 for agropastoralists, 1.64 for farmers, 1.55 for sedentary pastoralists and 1.44 for transhumants. Except the farmers' group whose income decreases from 1.24 to .24 increasing the agropastoralists' income has the highest income effect for the other groups. In total, it appears that the group that combines the most important activities is the one that benefits most from an increase in its income and induces more income effect for pastoralists (sedentary and transhumants) than any alternative .

Leakage Multipliers: Following Roland-Holst (1988) and Pyatt et al. (1985) the leakage multiplier matrix (L) is obtained by computing S × M where S is a k ×m matrix (k is the number of exogenous institutions, m the number of columns in the SAM multiplier matrix). Table 5 presents the resulting leakage multipliers. Leakage multipliers measure the income accruing to exogenous institutions as a result of a unit injection to each endogenous institution. For each column, it can be noted that multipliers sum up to 1 because of the closure condition that leakage equals injection in the linear model. The impact of a unit injection to endogenous institutions (crops, livestock, natural resources, retail, fish) on the three exogenous (government, savings and imports) is similar. About 0.01 for government, 0.3 for savings and 0.7 for imports. Imports, across the board, increase the most as a result of a unit injection to endogenous institutions. Yet, stakeholder groups' saving rates are high: 20% for farmers, 30% for agropastoralists, 35% for sedentary pastoralists and 55% for transhumant pastoralists.

Conclusions

The study showed the openness of the Madiama economy to the rest of the world and the importance of agricultural products and livestock in the economy. The livestock activity has high linkages with crops. Crops, particularly rice and vegetables have important production and income impacts. Retail (microentreprise) is less important than crops or livestock in terms of its impact on production and has a relatively small income effect.

The agropastoralist group benefits most from unit increases in activities as well as from an increase in its own income suggesting that this diversification is successful. Farmers, sedentary and transhumants pastoralists have respectively decreasing shares of impacts. The relatively low SAM multipliers for pastoralists (particularly transhumants) means that they cannot be impacted much with policies that stimulate general growth. This is probably due to their relative isolation from the other stakeholders. Consequently, only interventions targeted specifically at them will be able to induce these income increases. This result, if verified by subsequent analyses, has important implications for conflict mitigation strategies in the delta region of the Niger River. Specific interventions must be targeted at the pastoralists in order to impact them.

The results of this preliminary analysis will be expanded in the future to include policy implications of alternative commune actions and implications for conflict resolution in the commune. These analyses will disaggregate some production sectors in order to achieve more detail and understanding of the commune economy. For example, the retail (microentreprise) as well as the livestock sector will be broken out into sub-sectors small and large ruminants, since they differ in regard to export opportunities, owner characteristics and so forth. In addition, cereals will be disaggregated in order to investigate the presence of tradable cereals (for example maize) and their effects on the results. Finally, for resource use implications, the natural resource sector should be disaggregated.

References

Adelman, I., J.E. Taylor, S. Vogel (1988):"Life in a Mexican Village: A SAM perspective" Journal of Development Studies 25:5-24

Arndt,C.; Jensen,T.H; Tarp, F.(1998): "Structural Characteristics of the economy of Mozambique: a SAM-based analysis", DERG, University of Copenhagen

Bulmer-Thomas (1982): "Input-output Analysis in Developing Countries: Sources, Methods and Applications" John Wiley

Daget, J. (1994): *La pêche dans le Delta Central du Niger-Approche pluridisciplinaire d'un système de production halieutique,* Avant-propos, Jacques Quensière ed. I.E.R. – ORSTOM Karthala.

Dorosh, P.A., Bernier, R., A. R. Randrianarivony, and C. Rasolomanana (1991): "A Social Accounting Matrix for Madagascar: Methodology and Results", Working Paper #6, Ithaca, NY, CFNPP.

Lae, R., Weigel, J-Y, (1994): *Adaptabilité des pêcheurs aux changements environnementaux et économiques* in La pêche dans le Delta Central du Niger-Approche pluridisciplinaire d'un système de production halieutique, Jacques Quensière ed. I.E.R. -ORSTOM Karthala.

Miller R.E; P.D Blair (1985): "Input-output Analysis: Foundations and Extensions" Prentice Hall

Pradham, B.K; Sahoo A; Saluja M.R (1999): "A social Accounting Matrix for India, 1994-95" in Economic and Political Weekly 34: 48 3378-3394

Pyatt, G.; Round J.I (1985): "Accounting and Fixed-Price Multipliers in a Social Accounting Matrix Framework" in *Social Accounting Matrices: A Basis for Planning* by Pyatt G. and J.I. Round (Eds.) World Bank

Roland-Holst, W. D.(1988): "Relative Income Distribution in the United States: A Social Accounting Perspective" Unpublished Paper, Mills College ,Oakland, California, USA

Sada Sy B. (1994) *La pêche dans le Delta Central du Niger-Approche pluridisciplinaire d'un système de production halieutique,* Préface, Jacques Quensière ed. I.E.R. –ORSTOM Karthala.

Sadoulet, E., De Janvry, A., (1995): "Quantitative Development Policy Analysis" The Johns Hopkins University Press.

Subramanian, S: (1988): "Production and Distribution in a Dry-Land Village Economy in the West Indian Deccan" Ph.D. dissertation, University of California, Berkeley.

Sofara 1996 Census books, Department of Sofara office, Djenné Cercle, Mopti, Mali.

Taylor, J. E., Adelman, I.: "Village economies (1996): The design, estimation, and use of village wide economic models" Cambridge University Press.

Appendix 1: Social Accounting Matrix outline, Madiama Commune, Mopti, Mali, 1999 – Million

	ACTIVITIES						
	Cereals	**Rice**	**Veget**	**Legumes**	**Livestock**	**Fish**	**Retail**
Activities							
Cereals	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0
Veget	0	0	0	0	0	0	0
Legumes	0	0	0	0	0	0	0
Livestock	0	0	0	0	0	0	0
MeatFish	0	0	0	0	0	0	0
Retail	0	0	0	0	0	0	0
NatRes	0	0	0	0	0	0	0
Gvt Services	0	0	0	0	0	0	0
Durables	0	0	0	0	0	0	0
COMMODITIES							
Cereals	8.21	0	0	0	11.38	0	0
Rice	0	28.05	0	0	0.907	0	0
Veget	0	0	1.1493	0	0.074	0	0
Legumes	0	0	0	0.3923	2.4454	0	0
Livestock	0	0	0	0	3.5513	0	0
Fish	0	0	0	0	0	0.6771	55.6915
Retail	3.8535	1.5	4.19	0	44.6285	0	77.2578
NatRes	0	0	0	0	10.0975	0.31598	0
Gvt Services	0	0	0	0	0	0	0
Durables	0	0	0	0	0	0	0
FACTORS							
Family Labor	324.2573	472.4437	65.53844	11.0417	546.459586	24.31131	110.6296
Hired Labor	13.16603	13.4241	0.05156	0.00125	26.468702	0	0
Capital(Eqpt)	2.331826	0.27765	0	0.33446	2.576114	0.179311	0.135302
Land	0.63998	2.278	0	0	0	0	0
INSTITUTIONS							
Farmers	0	0	0	0	0	0	0
AgroPast	0	0	0	0	0	0	0
SedPast	0	0	0	0	0	0	0
Transhum	0	0	0	0	0	0	0
Central Govt	0	0	0	0	0	0	0
Total Institutions							
CAPITAL							
Savings	0	0	0	0	0	0	0
ROW							
Imports	0	0	0	0	0	0	0
TOTALS	352.458636	517.97345	70.9293	11.76971	648.588102	25.483701	243.714202

Appendix 1. Social Accounting Matrix outline, Madiama Commune, Mopti, Mali, 1999 – Million FCFA

	COMMODITIES						
	Cereals	**Rice**	**Veget**	**Legumes**	**Livestock**	**Fish**	**Retail**
Activities							
Cereals	195.9733	0	0	0	0	0	0
Rice	0	205.0028	0	0	0	0	0
Veget	0	0	70.9293	0	0	0	0
Legumes	0	0	0	11.7706	0	0	0

Livestock	0	0	0	0	410.2522	0	0	
Fish	0	0	0	0	0	25.4837	0	
Retail	0	0	0	0	0	0	68.4864	
NatRes	0	0	0	0	0	0	0	
Gvt Services	0	0	0	0	0	0	0	
Durables	0	0	0	0	0	0	0	
COMMODITIES								
Cereals	0	0	0	0	0	0	0	
Rice	0	0	0	0	0	0	0	
Veget	0	0	0	0	0	0	0	
Legumes	0	0	0	0	0	0	0	
Livestock	0	0	0	0	0	0	0	
Fish	0	0	0	0	0	0	0	
Retail	0	0	0	0	0	0	0	
NatRes	0	0	0	0	0	0	0	
Gvt Services	0	0	0	0	0	0	0	
Durables	0	0	0	0	0	0	0	
FACTORS								
Family Labor	0	0	0	0	0	0	0	
Hired Labor	0	0	0	0	0	0	0	
Capital(Eqpt)	0	0	0	0	0	0	0	
Land	0	0	0	0	0	0	0	
INSTITUTIONS								
Farmers	0	0	0	0	0	0	0	
AgroPast	0	0	0	0	0	0	0	
SedPast	0	0	0	0	0	0	0	
Transhum	0	0	0	0	0	0	0	
Central Govt	0	0	0	0	0	0	0	
Total Institutions								
CAPITAL								
Savings	0	0	0	0	0	0	0	
ROW								
Imports	313.1809	20.76969	3.795578	59.96981	276.26701	102.675597	315.431425	48
TOTALS	509.1542	225.77249	74.724878	71.74041	686.51921	128.159297	383.917825	54

Appendix 1. Social Accounting Matrix outline, Madiama Commune, Mopti, Mali, 1999 – Million FCFA

	FACTORS				Institutions			
	Family Labor	**Hired Labor**	**Capital(Eqpt)**	**Land**	**Farmers**	**AgroPast**	**SedPast**	**Transhum**
Activities								
Cereals	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0
Veget	0	0	0	0	0	0	0	0
Legumes	0	0	0	0	0	0	0	0
Livestock	0	0	0	0	0	0	0	0
Fish	0	0	0	0	0	0	0	0
Retail	0	0	0	0	0	0	0	0
NatRes	0	0	0	0	0	0	0	0
Gvt Services	0	0	0	0	0	0	0	0
Durables	0	0	0	0	0	0	0	0
COMMODITIES								
Cereals	0	0	0	0	226.5395	204.3053	47.2603	10.35212
Rice	0	0	0	0	98.40711	75.19646	15.75832	5.2396
Veget	0	0	0	0	23.1158	42.0647	1.07559	7.245488
Legumes	0	0	0	0	58.83713	5.3408	3.75848	0.4127
Livestock	0	0	0	0	49.6067	134.2907	148.525	71.15771
MeatFish	0	0	0	0	33.76504	25.20564	8.810493	3.456024
Retail	0	0	0	0	96.7902	76.248	62.2226	15.382225

NatRes	0	0	0	0	16.644515	17.6468	3.9249	3.0013127
Gvt Services	0	0	0	0	0	0	0	0
Durables	0	0	0	0	0	0	0	0
FACTORS								
Family Labor	0	0	0	0	0	0	0	0
Hired Labor	0	0	0	0	0	0	0	0
Capital(Eqpt)	0	0	0	0	0	0	0	0
Land	0	0	0	0	0	0	0	0
INSTITUTIONS								
Farmers	516.117	16.1903	2.6165	1.1	31.4773	2.89231	0.25796	0.22309
AgroPast	570.503	17.775	2.7143	1.3	2.7675	32.56083	1.336477	0.22309
SedPast	313.3308	14.6849	0.3995	0.51798	0.97222	2.319956	19.68656	0.59809
Transhum	158.032308	4.4614	0.4044	0	2.52381	3.566856	3.91458	5.78819
Central Govt	0	0	0	0	3.31	4.201837	1.914634	0.664
Total Institutions								
CAPITAL								
Savings	0	0	0	0	60.9544	131.90265	102.71844	104.4368
ROW								
Imports	0	0	0	0	8.9242	0.790075	6.05726	0.572105
TOTALS	1557.983108	53.1116	6.1347	2.91798	714.635425	758.532914	427.221594	228.752545