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## MARKET GARDENING EXPLOITATIONS IN THE LOWLAND OF SOURGOU-CENTER: BETWEEN VARIABILITY IN FARMING PRACTICES, LAND PRECARITY, SPATIAL- ENVIRONMENTAL INEQUALITIES, AND PRODUCERS' ADAPTATION STRATEGIES

### ABSTRACT

In the center of the commune of Sourgou, market gardening is developed during the dry season, facilitated by the development of the Sourgou-center dam and the presence of wetlands along the lowland area. Based on a literature review combined with quantitative and qualitative data collected from market garden producers and landowners in the Sourgou-center lowland, this article analyzes the principles of development and the inequalities resulted from market gardening, as well as it identifies the various adaptation strategies used by farmers to tackle land insecurity in the research area. A total of 143 farmers, 8 landowners and 8 heads of market garden producers' associations were interviewed. The results of the survey show that the land in the Sourgou-center lowland is used for market gardening by both native populations (64.11 %) and non-native populations (35.89 %). Market gardening generated inequality within the market garden sites of the Sourgou lowlands, reflected in plot size (23.12 %), and segregation in terms of spatial or environmental occupation into producer subgroups based on residence or autochthony (75.14 %). Plots smaller than 0.18 ha are more frequently farmed by non-landowning farmers, while larger plots (larger than 0.18 ha) are usually farmed by landowners or farmers from their family. In addition, the precarious nature of market gardening is reflected in the size of the plots and the principles and rules governing the development of market gardening land in the research area. The strategies developed by producers and especially landless people to tackle the precarious land tenure

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Fecha de recepción: 18-07-2023. Fecha de aceptación: 13-12-2023.

and exploitation in the area under investigation include respect for the principles and rules of exploitation (FRC = 0.81), operating plots within solidarity groups (FRC = 0.69), respecting landowners and market-gardening group leaders (FRC = 0.28), indirect tenancy (FRC = 0.17) and choosing to operate plots on different market-gardening sites (FRC = 0.02).

KEYWORDS: market gardening; Sourgou-center lowland; spatio-environmental inequality; land insecurity; adaptation strategy; Burkina Faso.

## EXPLOTACIONES DE HORTICULTURA EN LAS TIERRAS BAJAS DEL CENTRO DE SOURGOU: ENTRE LA VARIABILIDAD EN SUS PRÁCTICAS AGRÍCOLAS, LA PRECARIEDAD DE LA TIERRA, LAS DESIGUALDADES ESPACIOAMBIENTALES Y LAS ESTRATEGIAS DE ADAPTACIÓN DE SUS PRODUCTORES

### RESUMEN

En el centro de la comuna de Sourgou, la horticultura se lleva a cabo durante la estación seca, facilitada por el desarrollo de la presa del centro de Sourgou y la presencia de humedales a lo largo de su zona baja. A partir de una revisión bibliográfica combinada con datos cuantitativos y cualitativos provenientes de productores hortícolas y terratenientes de las tierras bajas del centro de Sourgou, este artículo analiza los principios de desarrollo y las desigualdades derivadas de la horticultura, además de identificar las diversas estrategias de adaptación utilizadas por los agricultores para hacer frente a la inseguridad de la tierra en la zona de investigación. Se entrevistó a un total de 143 agricultores, 8 propietarios de tierras y 8 responsables de asociaciones de productores hortícolas. Los resultados del estudio muestran que las tierras de la llanura del centro de Sourgou se destinan a la horticultura entre la población autóctona (64,11 %) y no autóctona (35,89 %). La horticultura genera desigualdades entre las parcelas de horticultura de la llanura de Sourgou, que se reflejan en su tamaño (23,12 %) y en la división en términos de ocupación espacial o medioambiental en distintos subgrupos de productores sobre la base de la residencia o la autoctonía (75,14 %). Las parcelas menores de 0,18 ha son cultivadas en mayor medida por agricultores no propietarios, mientras que las parcelas mayores (de más de 0,18 ha) son cultivadas por propietarios o agricultores de una misma familia. Además, la naturaleza precaria de la horticultura se refleja en el tamaño de las parcelas y en los principios y normas que rigen el desarrollo de esta actividad en la zona estudiada. Las estrategias desarrolladas por los productores y especialmente por los que carecen de terrenos para hacer frente a la precariedad en la tenencia y explotación de la tierra en el área de análisis incluyen el respeto a los principios y normas de explotación (FRC = 0,81), la explotación de las parcelas en cooperativas (FRC = 0,69), el respeto a propietarios y a líderes de grupos de horticultura (FRC = 0,28), la tenencia indirecta (FRC = 0,17) y la alternativa de explotar los terrenos en distintas localizaciones (FRC = 0,02).

PALABRAS CLAVE: horticultura; zona baja del centro de Sourgou; desigualdad espacioambiental; inseguridad de la tierra; estrategia de adaptación; Burkina Faso.

## INTRODUCTION

Initiated in the colonial period (Gross, 2018, p. 23), the cultivation of off-season vegetables in Pabré and the Bam area around the 1920s (Zoungrana, 1998, p. 26), an irrigated activity around micro and large dams, as well as in lowland areas, continues to draw the attention of a significant majority of Burkinabe. The development of irrigated and market-garden production in rural and peri-urban areas has contributed to the reorganization and transformation of Sahelian landscapes (Gross, 2018). Furthermore, it has played a role in reshaping power relations among stakeholders (Yaméogo, 2005, p. 111) and has led to territorial inequality in terms of development between areas heavily involved in irrigated production and those weakly irrigated or not irrigated at all.

Beyond territorial inequalities (Yaméogo et al., 2020), the development and exploitation of irrigation areas give rise to various forms of disparities, namely environmental, spatial, land, social, and gender inequalities (Le Roy, 2006). They contribute to the exclusion of vulnerable classes in society, particularly women. Inequality in lowland areas, in a context of land pressure, also fosters intergenerational conflicts (Di Roberto, 2019, p. 44). Additionally, it marginalizes the poor links within the community who typically only exploit portions of plots (Gharbi & Elloumi, 2023).

Land issues in lowland areas also lead to a redefinition of access and exploitation rules, contributing to the exclusion of the weaker sections in terms of land access (Kra, 2018, p. 228). The submerged zone in the center of the commune of Sourgou is being developed by a number of actors from diverse backgrounds (Kougsin, Namalgan, Sabou, Ziniare, Ouagadougou), especially during the dry season. They exploit market garden sites developed by rural development projects such as external actors –namely, NGOs–, but also by the local population itself (Sanou et al., p. 202). This diversity of farm types, combined with the plethora of actors involved, has necessitated the development of unwritten farm rules dictated by landowners and market gardening group leaders or farm managers. These principles concerning the use of market garden land often contribute in varying degrees to the land insecurity of certain farmers, such as the landless or farmers who do not own land. They therefore contribute to making it difficult for these actors to access and exploit the land. In order to respond to or adapt to land management mechanisms, landless farmers develop adaptive strategies to temporarily secure land tenure. This study aims to analyze the rules and inequalities involved in the market gardening of the Sourgou-center lowland. It also identifies the different adaptation strategies of famers facing land precariousness.

## LITERATURE REVIEW, PRESENTATION OF THE RESEARCH AREA AND METHODOLOGICAL APPROACH

The main points of this section are the state of the literature on the subject, the presentation of the research framework and the working methodology.

### *Literature review*

The themes addressed in the literary review are essentially all the inequalities generated by the exploitation of low-lying areas, submerged zones, or plains. These inequalities range from access to land to its valorization, as well as access to irrigation water. This literature also deals with the adaptation strategies developed by actors in irrigation areas so as to achieve plausible land security.

#### Inequality in lowland areas

Several previous studies have addressed inequalities in lowland areas. Violence surrounding land access leads to a deep fracture and social exclusion (Touoyem, 2022). It creates inter and intra-ethnic inequality within the same social stratum (Leo & Garambois, 2017, p. 5). The dynamics of agricultural land management and that of submerged areas, which have led to new forms of access to land such as selling and renting, have also led to inequalities between farmers with insufficient funds and others who are better endowed financially (Gharbi & Elloumi, 2023, p. 9). These reforms have contributed to exclude a large number of farmers not only from access to land, but also from making major investments or developing it (Roy, 2006; Ouassissouet al., 2019). It also creates relationships of domination and social injustice in land governance within irrigated perimeters (Daré et al., 2023).

Gender inequalities in lowlands and agricultural areas are more a question of discrimination between men and women in terms of access to land or farm size (Le Roy, 2006; Sanou, 2008, p. 43; Tall et al., 2002, p. 29). They therefore contribute to the social vulnerability of farmers (Serpantié et al., 2019, p. 9), particularly women.

In addition to social and gender inequalities, the development of dams for irrigation and the exploitation of lowlands create other territorial or intra-territorial dualities and inequalities in terms of unequal access to factors of production (Kadiri & El Farah, 2013, p. 3).

However, the inequalities discussed in the literature rarely take into account the spatio-environmental inequalities generated by the distribution or spatial occupation of the farm site environment into producer sub-groups based on autochthony or residence.

#### Adaptation strategies to land tenure insecurity in market garden or lowland production areas

The problems of insecurity and land pressure in rural areas have prompted farmers to develop adaptation strategies. Farming in the “Tos” forest in Bouaflé (Côte-d’Ivoire) has required intensification, a crop association or the practice of other non-agricultural activities as a response to land pressure (Konan & Aloko-N’guessan, 2019, p. 167). Land tenure arrangements between production actors have been identified by other authors as farm-level land tenure strategies in lowland areas. These plot-related arrangements include temporary loans, leases, and indirect tenancy (Adamczewski et al., 2013, p. 43; Clément et al., 2019, p. 16). Although they are informal and contrary to specifications, these land tenure arrangements enable the plot beneficiary to overcome land constraints and result in the failure of the land tenure system in force in lowland areas (Adamczewski, 2014, p. 252; Gharbi & Elloumi, 2023,

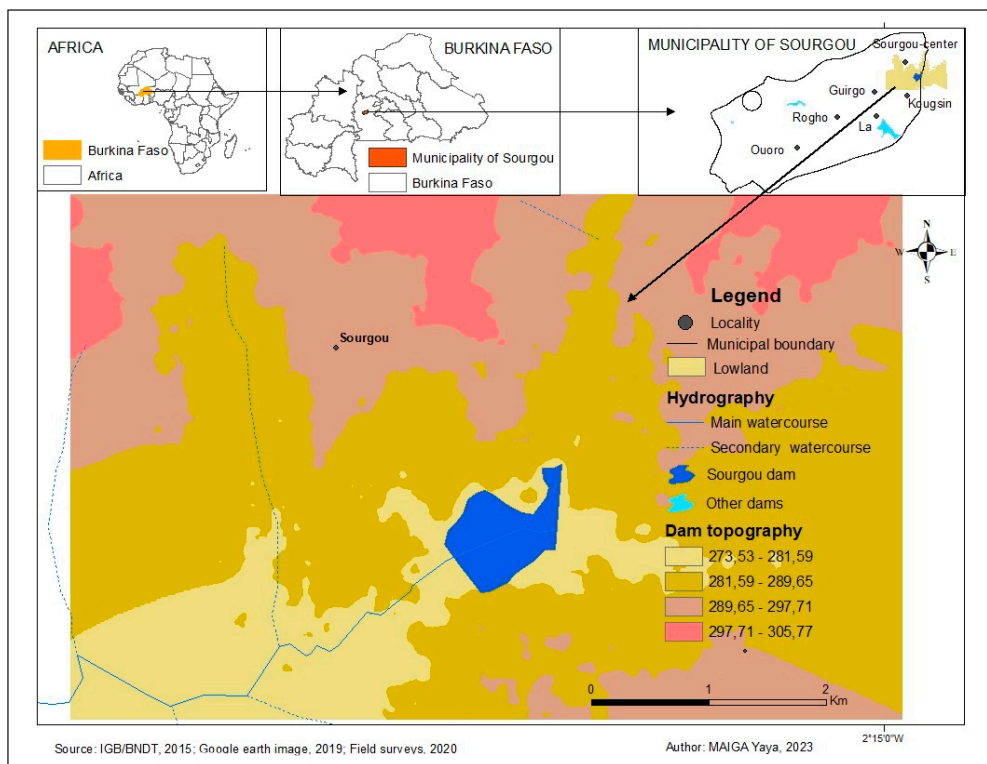
p. 10). In some cases, agricultural migrants or land-seeking farmers who are likely to be in a situation of land insecurity opt to buy land to protect themselves from eviction (Nana, 2018, p. 14).

All the coping strategies for land tenure pressure and insecurity in lowland farming areas fail to consider the importance of group farming sites, as well as the weight and roles of influential landowners, group leaders and farm managers in land tenure security mechanisms.

*Presentation of the research framework*

The research area is the lowland of Sourgou-center. The commune of Sourgou is one of the 14 communes of the Boulkiemdé province in central-western Burkina Faso. It lies between 12° 7' 0" and 12° 1' 30" north latitude and between 2° 26' 30" and 2° 15' 30" west longitude. The vast majority of the commune of Sourgou is located on flat terrain, with altitudes fluctuating between 200 and 300 m. The lowland sites occupy around 30 % of the communal land area (PCD Sourgou, 2015). The Sourgou-center lowland (273.53-281.59 m) is drained by a main stream (river), a tributary of the Mouhoun watershed, and secondary streams (figure 1).

Figure 1. Geographical location of research area



This multiplicity of lowland areas, combined with the development of the Sourgou-center agricultural dam between 1984 and 1985, makes market gardening possible in the research area. Both sexes are involved in market gardening in the lowlands of Sourgou-center. However, the number of women producers is much higher (i. e. 81.82 %) than that of men (i. e. 18.18 %). Market gardening is the main economic activity for women in the study area during the dry season. They only benefit from a right of exploitation. As for the men, in addition to market gardening, they engage in other activities such as livestock breeding.

### *Methodological approach*

It covers the methodology of demographic sampling, data collection, processing and analysis.

#### Data collection and demographic sampling

As for data collection, the methodological approach developed for this study is both quantitative and qualitative. The quantitative research involved individual questionnaires sent to market gardeners in the Sourgou-center lowland. The qualitative study involved interviews with 8 landowners and 8 leaders of market gardening groups in the Sourgou-center lowlands. All these data were collected at market garden sites along the Sourgou-center lowland and dam. The questionnaires and interview guides were structured into five (5) parts: socio-demographic characteristics, spatio-environmental inequalities that emerge through the use of market garden sites, operating principles and rules, reasons for withdrawing from a market garden plot and producers' coping strategies in the face of land insecurity and land development in the research area.

The methodological approach was also based on documentary research. Field observation enabled us to identify the various inequalities that arise on the market garden farm at Sourgou-center.

A total of 143 market gardeners (out of a total of around 181 producers) were interviewed using Fisher's demographic sampling formula adopted by Coulibaly et al. (2021, p. 64):

$$n = \frac{t^2 \times P \times (1 - P)}{e^2}$$

Where  $n$  represents the target population to be surveyed;  $t$ , the 90 % confidence level in this case (standard value of 1.65);  $P$ , the proportion of the elements of the parent population in percent, here 15 %, and  $e$ , the margin of error at 5 % (standard value of 0.05).

These market gardeners in the lowlands of Sourgou-center were surveyed on the basis of their willingness to answer our questions.

#### Data processing and analysis

The data collected in the field were processed and analyzed. They are presented in the form of statistical tables and figures based on frequency calculations. Chi-square statistical tests were also used to show the dependencies between certain variables in the study.

In order to identify the adaptation strategies most frequently adopted by respondents in the face of land insecurity in the study area, we determined the relative frequency of citation (FRC) of each adaptation strategy. This shows the importance of a given strategy for the subjects surveyed. It is calculated according to the following formula (Tardío & Pardo-de-Santayana, 2008, p. 28):

$$FRC = \frac{FC}{N}$$

Where, *FRC* represents the relative frequency of quotation of a given strategy; *FC* is the number of informants who mention the strategy or the frequency of quotation and *N* the total number of informants interviewed during the field surveys. It varies from 0 to 1. A high *FRC* value or one close to 1 indicates the relevance of the said adaptation strategy in the face of land tenure and exploitation insecurity within the population surveyed, while a low *FRC* value or one close to 0 reflects a low tendency for the population to adopt such an adaptation strategy. It also expresses a low level of protection of this strategy against land insecurity in the research locality.

## RESULTS AND DISCUSSIONS

The results successively present the socio-demographic characteristics of the population surveyed, land tenure and development insecurity as reflected in spatio-environmental inequalities and the principles of market garden plot management, as well as coping strategies in the face of this land tenure insecurity in the Sourgou-center lowland.

### *Socio-demographic characteristics*

The market garden sites in the Sourgou lowlands are farmed by a native population (i. e. 47.18 %) and a non-native population (i. e. 52.82 %). The allochthonous population is made up of people from neighboring villages such as Namalgan, as well as from towns such as Sabou, Ziniare and Ouagadougou (Sanou et al., 2022, p. 198). Furthermore, table 1 shows that the majority of non-native respondents are farmers, i. e. 23.44 %. As for natives, they are made up of 21.13 % simple farmers, 15.49 % landowners, 7.75 % group leaders and 2.82 % farm managers. Landowners (who also represent the native) in the lower Sourgou are divided among several families. These include Natenga, Kombeodo (Gnognonché), Gozourgou (Noonbguin), Gogo, Beneodo and Teengsoob-yiire. These families mainly come from the village of Kougsin and Sourgou-center. As a reminder, we refer to simple farmers in this paper as producers who are neither landowners nor farm group managers or leaders.

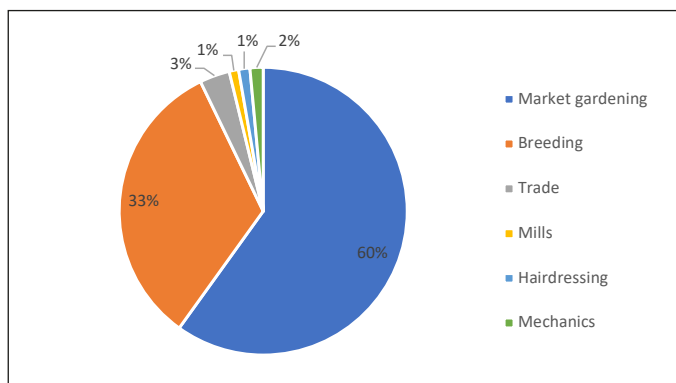
Table 1. Residence and family origin of producers

Family origin	Origin					
	No native		Native		Total	
	Number	Rate (%)	Number	Rate (%)	Number	Rate (%)
Family landowner	15	10.56	22	15.49	47	26.06
Family group leader	10	7.04	11	7.75	21	14.79
Simple farmer	49	34.51	30	21.13	79	55.63
Farm manager	1	0.70	4	2.82	5	3.52
Total	76	52.82	67	47.18	143	100.00

Source: field surveys, 2020.

As elsewhere in Burkina Faso, agriculture plays a significant role in the economic activities of the studied municipality. Through its rain-fed variant, it is the main activity of the interviewed individuals in the study area (i. e. 95.27 %). However, it is observed in the study area that rain-fed agriculture is supplanted by market gardening in the dry season, involving a significant portion of the population, with a rate of 59.92 % (figure 2).

Figure 2. Economic activities in the dry season in Sourgou



Source: field surveys, 2020.

The crops mostly grown by market gardeners are onions (i. e. 51.15 %), cabbage (i. e. 17.94 %) and local eggplants (i. e. 16.41 %). The choice of the type or species of market garden crops to be grown is not imposed. So just like the market garden sites cultivated by women in Senoufo country (Côte d'Ivoire), the choice of crops is left to the plot owner, depending on his or her ability to maintain the plot and



market demand (Fromageot et al., 2005, p. 57). The beneficiary of the plot has complete freedom and no constraints to decide on the type(s) of market garden crops to produce.

Market gardening in the lowlands of Sourgou-center gives rise to spatio-environmental inequalities.

*Sourgou market garden sites: production zones of spatial and environmental inequality and land tenure insecurity*

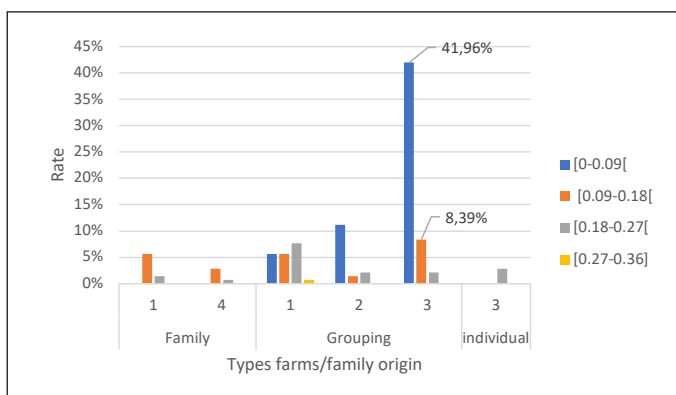
The production of inequality within the market garden sites of the Sourgou lowlands is reflected in plot size (i. e. 23.12 %), occupation of space (environment) (i. e. 75.14 %) according to the perception of the interviewees. Only 1.75 % of the respondents have no idea about social, environmental, and spatial inequalities in the market gardening activities in the research area.

**Inequality in farm plot size**

The size of the plots constitutes sources of spatial inequalities in the lowlands of Sourgou.

Inequality in the size of market garden plots is more noticeable in associated sites. In our context, associated sites refer to market gardening operations managed by a group of producers linked to rural development initiatives. In these farms, figure 3 shows that plots smaller than 0.18 ha are farmed at a rate of 50.35 % by farmers requesting plots. This category of producers is made up of non-natives and temporary farmers.

Figure 3. Size inequality of market garden plots in the Sourgou lowlands



Source: field surveys, 2020.

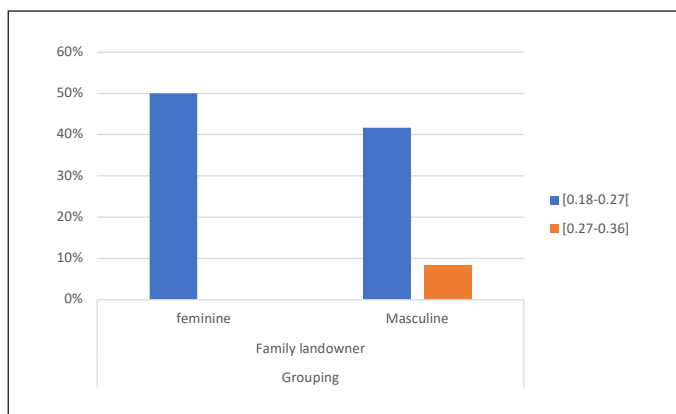
1: Farmers from landowner families; 2: Farmers from group leaders' families;  
 3: Simple farmers; 4: Farmers from farm managers' families.  
 Family: Family site; Group: Group site; Individual: Individual site

The larger plot areas (greater than 0.18 ha) are, on the other hand, cultivated by landowners or producers from these families, with a rate of 8.39 %. Furthermore, the chi-square independence test between the family origin of the operator and the plot area shows a relationship between these two

parameters ( $p\text{-value} = 9.2725E-11 < 0.05$ ). Enjoying the status of landowners or leaders, they secure the largest plot areas compared to other farmers. This is justified by the fact that it is these landowners who grant their land to groups of producers or to various projects for the development of the farm. Additionally, in other informal market garden sites, it is the landowners who convert their agricultural fields from the rainy season into vegetable gardens during the dry season. Also, according to Tall et al. (2002, p. 29), landowners' plots are larger than those of other farmers. Influential groups, commonly referred to as landowners, generally take up a significant portion of irrigated land, leaving the landless with a small portion of land (IIMI, 1996; GRET, 1992; Gouba, 1995, p. 45; Traoré, 2012, p. 75).

Analysis by gender shows a virtual absence of women in the categories of producers with plot sizes between 0.27 and 0.37, while men are represented at a rate of 8.33 % (figure 4).

Figure 4. Plot size by gender, family origin and farm type



Source: field surveys, 2020.

Previous work in irrigation areas also shows this gender inequality in relation to plot size (Tall et al., 2002, p. 29; Le Roy, 2006). Serpantié et al. (2019, p. 9) describe inequality in farm size as social vulnerability in the Dano lowland.

In addition to expressing inequality, the small size of farm plots in the research area also reflects land insecurity. Indeed, the average size of a farm plot is 0.09 ha. Furthermore, table 2 shows that a greater majority of farmers with secure land tenure farmed areas of between 0.18-0.27 and 0.27-0.36 ha, i. e. 14.69 % and 0.70 % respectively, compared with farmers with insecure land tenure. Furthermore, the chi-square test ( $p\text{-value} = 0.0014916 < 0.05$ ) shows a dependent relationship between the area farmed and the farmer's perception of land tenure insecurity.

Table 2. Land insecurity and farm plot size

Land insecurity	Plot size									
	[0-0.09[		[0.09-0.18[		[0,18-0.27[		[0.27-0.36]		Total	
	Number	Rate (%)	Number	Rate (%)	Number	Rate (%)	Number	Rate (%)	Number	Rate (%)
Yes, land insecurity	29	20.28	13	9.01	3	2.10	0	0	45	31.47
No, land insecurity	55	38.46	21	14.69	21	14.69	1	0.70	98	68.53
Total	84	54.74	34	23.78	24	16.78	1	0.70	143	100

Source: field surveys, 2020.

In the cultivation of irrigated perimeters in Mali (Tall et al., 2002, p. 40; Adamczewski et al., 2011, p. 3), the size of plots also constitutes a source of land insecurity among producers. These research findings align with studies conducted on irrigated perimeters in Mali, which has a local and traditional land management system similar to that of Burkina Faso. Additionally, these two neighboring countries share very close and similar social emergence contexts.

Inequality in the lowland of Sourgou is also manifested in the spatial occupation and organization of market garden sites.

### Environmental inequalities through market gardening in Sourgou

Market gardening in Sourgou reveals inequality in spatial and environmental occupation. Within the groups of producers, there is a noticeable division between groups of operators requesting plots or non-landowners and producers from the family of landowners. In fact, the landowners, who are the former landholders in the lowlands, retain the location or situation of their plots after the development and redistribution of the land portions. The lands of landowners or producers from landowner families are well-moistened, fertile, and easy to cultivate compared to other producers. In some cases, we observe proximity to wells or moist areas of the plots cultivated by the families of landowners and/or group leaders. This separation highlights a dynamic of social segregation that intensifies in the lowland exploitation zone of Sourgou-center. This social cleavage within market gardening operations in Sourgou reflects the social groups in the locality. Additionally, the emerging environmental inequality is explained by the diversity and plurality of production actors who not only come from different families but also have different origins. Among the producers, there are landowners, non-landowner operators, group leaders, male and female producers, and individuals of different generations. The land tenure status, manifested through being landowners or non-landowners, influential individuals, or leaders, contributes to the organization of space in the market garden sites in the lowland of Sourgou-center. The organization of space and the distribution of land among families and farmers thus reflect the history of colonization and land exploitation, structuring communal affiliations (Lavigne & Durand-Lasserre, 2009, p. 33). The control of space and the exploitation of the lowland in Sourgou-center thus lead to social divisions

within market garden sites. In the Kou basin, West Burkina Faso, Traoré (2012, p. 74) observes that initially settled producers or natives have acquired lands of better quality compared to other farmers.

The precarious land tenure of market gardeners in the lowlands of Sourgou is also explained by the principles and rules of exploitation.

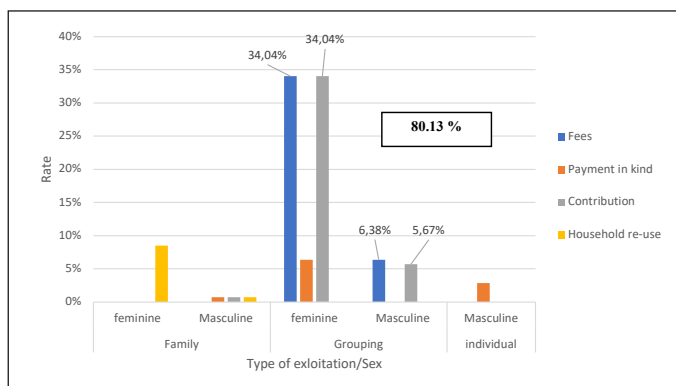
### *From production principles to market garden plot withdrawals in the Sourgou lowlands*

Market garden production in the lowlands of Sourgou-center is governed by production rules and principles.

### Variability of production rules and principles on market gardening sites in the lowlands of Sourgou-center

Farming a plot of land in the Sourgou lowlands requires certain modalities. The principles of exploitation in this study are different from the access modalities to the plot. They reflect the type of contract that binds the plot beneficiary to the landowner. The producer must comply with these clauses either during the development of the plot or after the harvest. Once granted, the plot must be cultivated according to the terms of the contract. The plot beneficiary is therefore obliged to fulfill the duties of land cultivation. The formalities for cultivating a market garden plot in Sourgou-center include: membership dues for the association or annual fee (i. e. 80.86 %), use of vegetables for family consumption (i. e. 9.22 %), and in-kind payment (i. e. 9.93 %). Although unwritten (Sanou et al, 2022, p. 205), these customary agreements are equivalent to terms of reference in large-scale irrigation. The rules for cultivating a plot vary from one site to another. Within market gardening production groups, the payment of membership dues for the association or the annual fee (i. e. 80.13 %) is the main condition for cultivating the plot (figure 5).

Figure 5. Distribution of market garden plot management formalities according to gender and type of farming in the Sourgou-center lowland



Source: field surveys, 2020.

The royalty or annual fee is a sum imposed on every operator in the group: hence its compulsory status. In the specific case of Sourgou's farmer-managed market garden sites, it is payable at the end of the dry season. It is used to fund the group's treasury. The amount fixed in all market gardens is capped at 1,000 FCFA per plot. These sums are collected and used for the group's needs, such as the purchase or repair of motor-driven pumps (i. e. 37.73 %), fencing (i. e. 17.85 %), the construction or rehabilitation of wells (i. e. 32.85 %). This operating principle is increasingly cited by women (i. e. 59.81 %) as compared to men (i. e. 10.28 %). This is justified by the tendency for market garden sites belonging to groups or associations to be exploited by women in the Sourgou-center lowlands. It also reflects women's difficulty in gaining access to individual market garden plots (Ouédraogo, 2019, p. 160). For Charlier et al. (2014, p. 50), this collective access to land by women is a fact common to the whole of West Africa. The payment of royalties is one of the production rules common to almost all market gardening or rice-growing perimeters in small and large-scale irrigation operated by a group of people (Gharbi & Elloumi, 2023, p. 7; Jourdain et al., 2011, p. 82; Ouédraogo, 2003, p. 29). In other cases, this fee is also paid in cash or in kind by plot tenants to landowners (Abou et al., 2018, p. 475). The amount to be paid may also vary from one site to another, or from one reservoir to another (Sanou, 2022, p. 525).

As for the family types, the operating principle imposed on growers generally consists in reusing vegetables directly for the family kitchen or using the income from sales for the family's needs (i. e. 20.25 %). This type of farming is more common among women, with a frequency of 18.69 %. These market gardeners are also the wives of the landowner or farm manager.

Payment in kind (mainly onions) at the end of the season is observed both in individual sites (2.49 %) and in group sites (5.61 %). In other words, speculative crops are paid in kind to the landowner or the landowner's family. This is a method of thanks and recognition in African societies. It can also be converted into cash.

Withdrawal of a plot from its beneficiary occurs in the event of non-compliance with management or operating principles.

#### Withdrawal clauses: precarious land tenure for market gardening in the lowlands of Sourgou-center

In the research area, withdrawal of a plot requires a violation of an exploitation principle. In addition to the withdrawal conditions applied to high rainfall lands, such as conflicts, adultery and/or fornication, and witchcraft, market garden plots in the lowlands of Sourgou-center have new rules developed as a result of the exploitation of group sites. On this subject, Z. R. and K. M., all landowner-grower managers in Sourgou said respectively that:

We withdraw the plot if the person doesn't respect the group's principles, like those who like conflict, because if there's a fight, we withdraw the plot. (Extract from interview with Z. R., 16/05/2020)

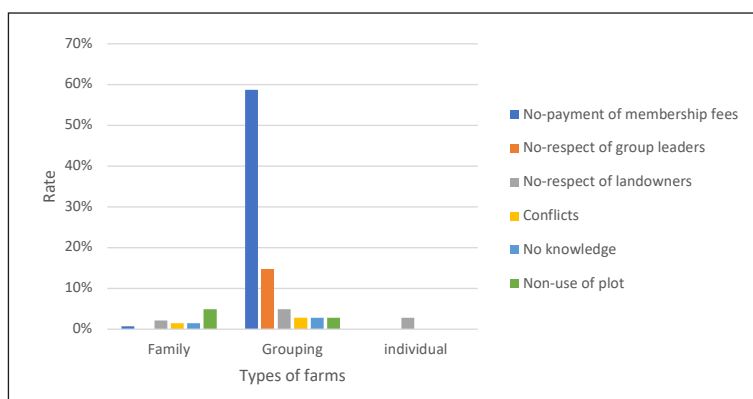
What can lead to the withdrawal of a plot here in the garden is non-payment of dues, brawlers, cases of theft, people who seek people's wives, cases of witchcraft. (Excerpt from interview with K. M., 23/06/2020).

These results corroborate the writings of IIMI (1996), Mathieu (n. d., p. 75) and Commons quoted by Maiga (2005, p. 85). According to these sources, in areas under cooperative management, social rules and values are transposed into the management of these sites.

As with farming formalities, cases of dispossession of a plot of land vary according to the type of farming.

Among market gardening groups in the Sourgou lowlands, non-payment of dues (at around 59 %) is the main reason for seizing an irrigated plot (figure 6).

Figure 6. Clauses governing seizure of a plot of land, by type of farm



Source: field surveys, 2020.

The mandatory nature of the membership fee provides a framework for market gardening activities, such as the rehabilitation of motor-driven pumps, market gardening wells and fencing. It serves as means of exerting pressure on the behavior of individuals to improve productivity and ensure proper maintenance of hydraulic structures (Legoupil et al., 1999, p. 241). Additionally, disrespect or rudeness by producers towards managers or leaders (i. e. 15 %) and landowners (i. e. 5 %) of the various market garden sites may be grounds for confiscation of the cultivation plot. Through their social status (husbands, elders) and responsibilities (landowners), they play a strategic role in land management and the operation of market garden sites in the study area. They position themselves as masters (Sanou et al., 2022, p. 205), key figures, or elders (Ouédraogo, 2004, p. 39) and wield irrevocable power (Droy, 1994, p. 6; Lavigne, 1992). Due to its ephemeral nature, given that human relationships are not only fragile but often tense, this principle places a significant proportion of producers, especially non-landowners, in a precarious situation regarding land tenure and plot development.

In addition to the reasons mentioned above, the occurrence of a conflict—particularly physical confrontations involving injuries or the use of edged weapons (knives, machetes, hoes) within the market garden exploitation sites in the lowlands of Sourgou-central— can be grounds for confiscating plots from the two conflicting parties. Conflicts are more prevalent within the exploitation sites of associations

(i. e. 3 %) as compared to family-owned sites (i. e. 1.40 %). This situation is explained by the divergence in the family background of the production actors in the associative market garden sites. The conflicts typically revolve around land and irrigation issues (watering plants). Despite the parcel boundaries set among beneficiaries, conflicts often arise among operators due to violations of these boundaries by one party. In addition to these types of conflicts, there are also conflicts over watering vegetables. These conflicts are attributed to the inadequacy of market garden wells and the depletion of water from these wells starting in February.

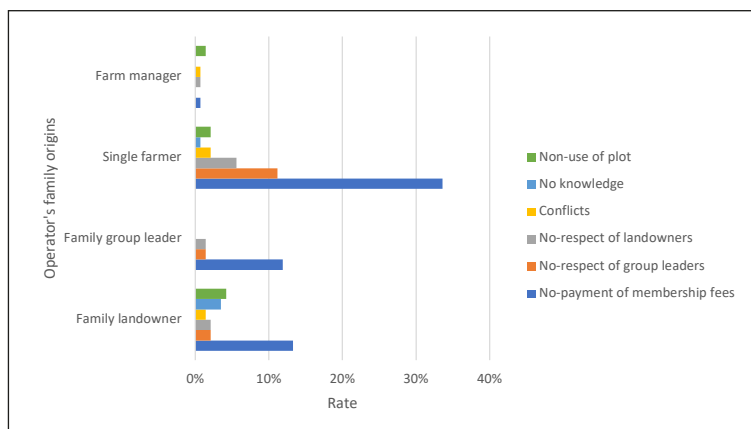
As for family-owned farms, any interruption in the cultivation of a plot results in the expropriation of the beneficiary (i. e. 5%). This restriction on the cultivation methods of the market garden lands in the lowlands of Sourgou-central is explained by the high demand for agricultural plots in the lowland area. The requirement for continuous exploitation of the plot without interruption, imposed on the producers under the threat of withdrawal of the plot from its beneficiary, is thus justified by the numerous economic stakes associated with the lowland areas, especially during the dry season for the farmers in the investigation site. It is indeed the general rule for the development of market garden plots in the lowlands of Sourgou. The right to develop highland areas (which also have very similar exploitation methods to lowland areas) in the Gouin region in the southwest of Burkina Faso also fades away with the cessation of cultivation of the granted plot (Nana, 2018, p. 12).

Frequently exploited by non-landowner and non-group-responsible operators, cases of confiscation of individual cultivation land are linked to the non-compliance with the donor or landowner at a rate of 3 %.

The procedures for seizing a plot also depend on the relationship or family ties that exist between the landowner and the producer. The chi-square independence test shows a very strong relationship between the withdrawal modalities of a plot and the family origin of the operator ( $p\text{-value} = 1.2743\text{E-}26 < 0.05$ ). Therefore, the reasons for confiscating a plot vary based on the social relations between the landowner and the producer. In addition to the requirement for continuous cultivation of the plot imposed on each beneficiary, figure 7 shows that the that disrespect for landowners and site managers is more frequently cited by simple farmers at respective rates of 5.59 % and 11.19 %, as reasons for dispossession of a market garden plot in the study area. Furthermore, individuals from a different family than that of the landowners and group managers increasingly express non-payment of annual fees (at a rate of 33.57 %) as a condition leading to the withdrawal of the plot in the research area. Thus, family ties strongly influence the decision to confiscate the market garden plot in the lowlands of Sourgou-central.

These results have also been proven by several other research studies (Karsenty, 2007, p. 150; Lavigne & Robin, 2019, p. 5; Ouédraogo, 2019, p. 169). According to the authors, producers in the lowland areas of Lofing and Houet in Burkina Faso also take advantage of the family fabric and social ties to access and exploit plots of land. However, in rural Côte d'Ivoire, the precariousness of land use among non-natives and non-landowners is often accentuated by land saturation (Lavigne & Durand-Lasserve, 2009, p. 81).

Figure 7. The conditions for withdrawing from a plot according to the producer's family origin



Source: field surveys, 2020.

Although they provide a framework for lowland production in the research area, these multiple rules and management principles expose farmers, especially landless farmers, to land tenure and plot development insecurity. In order to temporarily secure land tenure, the latter develop adaptation strategies.

#### *Adaptation strategies in the face of precarious land tenure for market gardening in the lowland of Sourgou-center*

Faced with the conditions for the withdrawal of cultivation plots, several land security strategies are developed by operators, particularly non-landowners in the lowlands of Sourgou-central. The implementation of these strategies by these actors is primarily driven by the status of land insecurity associated with cultivation plots. Although temporary, these strategies enable farmers to secure their plots for a certain period.

##### 1. Adherence to site management and exploitation principles:

The most widely adopted adaptation strategy is the adherence to the principles or rules of management of market garden lands, with a relative frequency of citation of 0.81 (table 3). As a reminder, these principles include the payment of fees and charges and the continuous cultivation of the plot. Additionally, Ouédraogo (2008, p. 39) notes that adherence to traditional land management rules is among the first strategies used by producers to minimize the risk of being dispossessed of their lands. According to GRET (1992), the objective of defining these rules is to maximize the security of producers, thereby encouraging production.



Table 3. Adaptation strategies and relative frequency of citation

Adaptation strategies	FC	FRC
Use of groups producers	99	0.69
Inter-perim migration	3	0.02
Compliance with operating conditions	117	0.81
Respect for landowners/managers	41	0.28
Complicity of stakeholders (indirect tenancy)	25	0.17

Source: field surveys, 2020.

CF: Citation frequency; FRC: Relative citation frequency

## 2. The use of irrigator groups or being a plot beneficiary in a group:

In addition to this, there is the option of being a member of a market gardeners' group. This adaptation strategy by producers has a relative frequency of citation of 0.69. Indeed, being a beneficiary of a plot within a group provides land security for the respondents. This result is in line with the findings of authors such as Lawali, Mormont & Yamba (2014, p. 9) and Bchir (2011, p. 96). The trust placed in groups by these user categories reflects a reduction in the risk of being dispossessed of the plot within these types of exploitations.

Also, according to Taleb (2014), cooperatives constitute a strategy adopted by market gardeners to enable sustainable land management. Moreover, table 4 shows that the individuals benefiting from plots within the association sites are the farmers who hope to have the greatest land security, i. e. a rate of 58.04 %. The use of plots on group sites is therefore a coping strategy for market gardeners in the Sourgou-center lowlands in the face of land withdrawals.

Table 4. Distribution of farm types according to perception of withdrawal from the producer's plot

Type of farm	Perception of withdrawal from the plot					
	Yes, afraid		No, afraid		Total	
	Number	Rate (%)	Number	Rate (%)	Number	Rate (%)
Family	2	1.40	13	9.09	14	10.49
Grouping	41	28.67	83	58.04	124	86.71
Individual	2	1.40	2	1.40	4	2.80
Total	45	31.47	98	68.53	143	100

Source: field surveys, 2020.

According to the surveys, this situation is justified by the formal nature of the association sites. These group vegetable farms in the study area are also managed by a small group of people consisting of landowners and temporary farmers (Sanou, 2021, p. 204).

3. Inter-perim market gardening migrations: This involves being a beneficiary of plots in multiple sites. This adaptation strategy also has a relative frequency of citation of 0.02. Ouédraogo (2008, p. 39) also notes the diversification of production sites as adaptation strategies used by market gardeners. The shortage of cultivable land in the lowlands of Sourgou-central explains the low citation of this adaptation strategy.

4. Respect for landowners and group leaders is also a coping strategy in the face of insecure land tenure and market gardening in the research area, with a relative frequency of 0.28. Influential individuals whose decisions are “almost like a law,” operators, especially those without land, also emphasize respect and consideration for these figures to temporarily secure land tenure.

5. The complicity of market gardeners in Sourgou-center in relation to plot abandonment (0.17): In some market gardening groups in the research zone, such as the Manitese group and the Nabonswendé group in Tamsin, there is an irregularity in the use of plots, and abandonment is still referred to in this study as strategic abandonment, as it is carried out with the possibility of return or securing. They are also temporary disposals. Indeed, after five (5) years of distribution of plots to the beneficiaries of the Manitese site, i. e. during 2016, table 5 shows that only 21.60 % of the respondents have carried out continuous development, without interruption and without recourse to indirect tenancy.

The excerpt from the interview below with Y. S., a market-gardener from the Sourgou-centre lowland, also shows the complicity that exists between plot beneficiaries in order to protect themselves from any withdrawal from the plot during the production season(s) in which they are absent.

I farmed the plot 2 years ago, otherwise it was K. I. my co-wife who worked here. (Interview with Y. S, market gardener, Sourgou, 10/05/2020)

Table 5. Number of years market garden plots have been in operation at the Manitese site

Name of site: Manitese	Number of years in operation											
	1		2		3		4		5		Total	
	E	T (%)	E	T (%)	E	T (%)	E	T (%)	E	T (%)	E	T (%)
	4	2.47	30	18.52	57	35.19	36	22.22	35	21.60	162	100

Source: field surveys, 2020.

The excerpt from the interview below shows that, without being a plot beneficiary during the redistribution, this respondent, as a temporary user, benefits from the indirect advantages of market garden plots within the market gardening groups of the Sourgou dam.

I've been cultivating the plots for two (02) years now... Every year, I go out to see if there are any empty plots, and I exploit them. Generally, I earn money for the women, and I pay the contribution for them. (Interview with K. D., market gardener, Sourgou, 21/05/2020)

Thus, without the plot remaining unexploited, the beneficiary of the plot entrusts or transfers his portion of land to another person to use during his absence. In all the market gardening groups of the Sourgou-center dam, prolonged non-use of the plot of land, generally between 2 and 3 years, without informing those responsible for the management of the site beforehand, could lead to the definitive dispossession of the plot. These are generally cases of travel, old age (loss of physical strength) or illness. These complications or land arrangements thus enable the first beneficiary of the plot to secure his land (Maiga, 2020, p. 56). According to Nouatin & Bachabi (2010, p. 9), these substitutes or new buyers are in reality "land guardians". For Adamczewski (2014, p. 62), peasant land tenure arrangements in irrigation zones are born out of the historical evolution of land tenure.

## CONCLUSION

In addition to its use during the rainy season, the Sourgou-center lowland is now known for its market gardening during the dry season. This market gardening activity has also been facilitated by the development of the Sourgou-center dam. Several producers of different origins now exploit this submerged area. This exploitation generates inequalities and discrimination between farmers. These can be summed up as spatial and environmental inequalities. The precariousness of land tenure and exploitation produced by the modalities and principles of land development in the Sourgou-center lowland has led to the adoption of several coping mechanisms and strategies, such as observance of the principles and rules of exploitation, respect for landowners and group leaders, exploitation of market gardening group plots, indirect feeds, and the diversity of market gardening plots on several farms.

The spatio-environmental inequalities in the market garden plots of the Sourgou-center lowland could be improved or reduced through a composition between production players and an increase in plot size on the various farms. This would not only help resolve conflicts and increase land tenure security (linked to plot size) but would also limit migration from one garden to another and contribute to improving the economic situation of producers.

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Cómo citar este artículo:

Maiga, Y. (2023). Market gardening exploitations in the lowland of Sourgou-center: between variability in farm-ing practices, land precarity, spatial-environmental inequalities, and producers' adaptation strategies. *Cuadernos de Geografía*, 111, 57-79. <https://doi.org/10.7203/CGUV.111.27137>



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