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# Unraveling the role of informal mutual aid networks in maintaining urban farms in Lubumbashi, Democratic Republic of Congo

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**Introduction:** The multiple constraints of urban agriculture have prompted farmers in Lubumbashi to turn to informal mutual aid networks. The survey data collected from 88 farmers chosen at random from the 202 farmers previously interviewed enabled us to decipher the crucial role of mutual aid in maintaining urban farms.

**Methods:** The survey data collected from 88 farmers chosen at random from the 202 farmers previously interviewed enabled us to decipher the crucial role of mutual aid in maintaining urban farms.

**Results:** The results show that 79.5% of the surveyed farmers resort to mutual aid to ensure the vegetable production cycle. More specifically, this mutual aid consists in sharing resources, for which the farmer would interact 15.1 times with other farmers, and in sharing agricultural know-how, for which the farmer would interact 11.6 times with other farmers. Four categories of resources are defined in this mutual aid network: highly exchanged resources with a high exchange intensity (hoes, watering cans, plant protection products and chicken droppings), highly exchanged resources with a low exchange intensity (land capital, spades, and seeds), lowly exchanged resources with a low exchange intensity (motor pumps and buckets) and non-exchanged resources (financing, labor, chemical fertilizers). Agricultural know-how such as soil preparation, soil fertility management, pest control and sales techniques are widely shared. Characteristics such as gender, age, experience, religious affiliation, and farmer status in the household are statistically significant explanatory factors of mutual aid. In addition, neighborhood relations, kinship and religious affiliation are social ties that enable farmers to help each other.

**Discussion:** The results provide useful information on the crucial role played by informal mutual aid networks in maintaining urban farms in the face of the negative consequences of chaotic urbanisation and climate change. The study recommends that policymakers and agricultural extension services take these networks into account when drawing up policies for disseminating innovations. For, although informal, they constitute powerful and inexpensive channels of communication in an inoperative institutional context of urban agriculture.

## KEYWORDS

farm households' survival, informal mutual aid networks, urban agriculture, Lubumbashi, Democratic Republic of Congo

## 1. Introduction

Family farming accounts for nearly 80% of farms in sub-Saharan Africa and employs 75% of the population (Mahamadou, 2016). Many authors stress that the State must play a crucial role in governance and institutional support for the agricultural sector, by facilitating the collaboration and participation of the various players in this sector, in the implementation of policies and strategies aimed at local development through the promotion of innovations likely to improve agricultural productivity (Guo et al., 2022; Smidt and Jokonya, 2022). For example, agricultural extension and subsidy programs can improve farmers' skills and their access to production resources (Guo et al., 2021; Girma and Kuma, 2022).

Furthermore, in budgetary terms, the agricultural sector is financed according to each country's level of development. Developing countries allocate fewer resources to this sector than developed countries, given their limited resources and the incompressible needs to be met in terms of collective consumption (Rodima-taylor, 2022). As a result, without support and faced with the challenges of urbanization and climate change, farmers in developing countries practice subsistence farming and are poor (Andrew et al., 2022). To survive, they develop informal mechanisms of survival such as mutual aid (Nsele et al., 2022).

In the Democratic Republic of Congo (DRC), nearly 75% of the population lives in rural areas and depends on subsistence farming (Molinario et al., 2020). Unfortunately, the DRC has a real infrastructural, technical and institutional vacuum, which makes it extremely difficult to train farmers through agricultural extension (Lambrecht et al., 2016; Kien, 2021).

In addition, road infrastructure is in poor condition or non-existent, reducing farmers' ability to access productive resources and market their produce (Pypers et al., 2011). Furthermore, Congolese agriculture generates very little income (Neema et al., 2022) and farmers struggle to lift themselves out of poverty (Bonnke et al., 2022). As a result, agriculture no longer attracts young rural people (Neema et al., 2022). To find new hope of survival, these young people are migrating to the country's major urban centers (Muhaya et al., 2022).

In the city of Lubumbashi, the country's 2nd largest city due to its rapid population growth (Useni et al., 2022), the severe economic crisis of the 1990s led several million of its inhabitants to turn to informal income-generating activities, such as urban agriculture (Tambwe et al., 2011).

Dominated by seasonal (dry season) production of short-cycle leafy vegetables, Lubumbashi's urban agriculture, faces the constraints of land tenure insecurity (Kesonga, 2017) soil poverty (Kasongo et al., 2013) soil pollution and heavy metal contamination of vegetables (Mununga et al., 2023) crop attack by *Agrotis ipsilon* larvae larvae (Mushagalusa and Nkulu, 2020). In addition, women, who were once in the majority (69.2%) and who, thanks to the support of the urban and peri-urban horticulture project (HUP project: 2000–2010), have acquired a certain amount of experience and autonomy (Moore et al., 2022) are increasingly handing over their farms to unemployed, inexperienced young people (Nsele et al., 2022). Faced with multiple constraints, newcomers to urban agriculture have adopted poor production practices that have only accentuated poor economic performance (Kesonga, 2017) and sanitary conditions on farms, in terms of heavy metal contamination of vegetables (Mununga et al., 2023).

To improve poor farm performance, farmers need to adopt innovative techniques (Mutshail, 2014). Agricultural innovations have effectively improved staple crop yields in sub-Saharan Africa

(Sotamenou and Parrot, 2013; Ochieng et al., 2022). Unfortunately, certain socio-demographic, economic and institutional factors hinder the sustained adoption of innovations by farmers in Lubumbashi. To ensure farm and household survival, most of the farmers resort to mutual aid, which enables them to overcome certain difficulties. More specifically, a recent study showed that mutual aid could make a positive contribution to the adoption of innovative techniques in urban agriculture, by helping to overcome obstacles linked to the use of organic matter, heavy physical work for older farmers and psychosocial barriers for younger farmers (Nsele et al., 2022).

Mutual aid is a rather informal form of cooperation (Ajates, 2020) that refers to the way in which members of a community support each other by pooling their resources to meet economic needs as they arise. Mutual aid is not an act of charity, but rather of solidarity (Dozono, 2022). According to Rodima-Taylor (2014) mutual aid is based on norms of reciprocity, trust and moral obligation. Historically, mutual aid has provided social support to farmers through informal networks (Archibald, 2007). This mutual aid in the agricultural sector can involve various aspects, such as the collective sharing and development of know-how and/or the sharing of scarce resources, such as land, labor, equipment, inputs and informal financing (Vansant et al., 2022).

Local infrastructure for production, processing and distribution actually becomes more affordable when farmers cooperate with each other, or with consumers and institutions (Lutz et al., 2017). In addition, mutual aid reduces the risks associated with agricultural production, especially among beginning farmers (Keeley et al., 2019). To help each other, farmers in developing countries mobilize social ties built through neighborhood relations, kinship, membership to the same work-sharing groups, or participation in common celebrations such as prayers, weddings and funerals (Wedajo and Jilito, 2020).

In the light of the above, this paper aims to investigate how urban farmers in Lubumbashi mobilize informal mutual aid networks to cope with the multiple constraints associated with urban agriculture and ensure the survival of their farms as well as their households. More specifically, the study will identify the characteristics of farmers likely to motivate their propensity to help each other, the social ties mobilized to help each other, the forms of assistance solicited and the intensity of mutual aid during a production cycle, as well as the reasons why some farmers resort to mutual aid and others do not. The aim of this paper is to decipher the dynamics of mutual aid in an urban farming context characterized by the arrival of many new entrants.

This article presents the results of empirical research that deciphers the role of informal mutual aid networks in maintaining urban farms in an urban context marked by chaotic urbanization and an inoperative agricultural institutional framework. The results will present informal mutual aid networks as a means of farm survival and as powerful, low-cost communication channels likely to play a crucial role in the development of policies and strategies for disseminating agricultural innovations to small-scale urban producers.

## 2. Materials and methods

### 2.1. Mutual aid in agriculture: conceptual background

Since Neolithic times, agriculture has been transformed by processes of collective action. To store, produce, use space, manage common resources, market and cope with risks, farmers have

organized themselves collectively, on their own initiative or under the impetus of the authorities, adopting common strategies built informally or established by law (Lucas et al., 2015).

Among small-scale farmers, cooperation is a key element in both farm management and household survival (Cush and Varley, 2013; Dessie et al., 2019). Thus, authors assert that small farmers often find it difficult to manage farms without cooperation (Möllers et al., 2018; Ortiz-Miranda et al., 2022). They rely on each other to clear land, harvest crops, build shelters, share equipment (Wiggins et al., 2010; Amogne, 2014) and know-how (Bosma et al., 2020). This interest in collaboration in agriculture has given rise to a variety of modes of cooperation (Ajates, 2020), which take place either within a formal framework (Dessie et al., 2019) or in more informal ways (Wedajo and Jilito, 2020).

In the literature, formal cooperation between farmers is mainly manifested in instituted farmer organizations such as associations, cooperatives (Ortmann and King, 2007) producer organizations (POs) and financial cooperatives. These formal organizations are collective institutions designed to support the interests of their members (Bizikova et al., 2020; De Herde et al., 2020) and are governed by notarized statutes (Mutshail, 2014).

Generally speaking, what distinguishes cooperative-like forms of collaboration from more informal modes is that the farmers pool their production resources through ongoing collective action, with a view to redistributing the advantages of cooperation (Dozono, 2022; Shirima, 2022).

In agriculture, cooperatives are promoted worldwide also as a means of increasing farmers' lobbying power (Ajates, 2020). Agricultural cooperatives, for example, enable farmers to respond to power imbalances by pooling their resources to maximize their buying and selling power (Muriqi et al., 2019). Furthermore, it appears that cooperatives play an important role in the economic sustainability of farms and in the adoption of agricultural innovations (Candemir et al., 2021; Timpanaro et al., 2023) not least because of the trust farmers place in the cooperative (Liu et al., 2022). The sustained development of cooperatives is an essential element of agricultural viability, and is mainly determined by the longevity of cooperation between members (Zhong et al., 2022).

In addition, these formal organizations can help small farmers access markets, credit, extension services and manage scarce resources. They can also strengthen farmers' production skills (Ruzzante et al., 2021) marketing and leadership skills, and improve their psychological well-being (Markelova et al., 2009). Building on these contributions, formal farmer organizations form an essential component of policies for development, agricultural productivity and poverty reduction (Frija et al., 2023; Jansen and Kalas, 2023). One study even argues that the ties forged through formal farmer-to-farmer cooperation encourage farmers to acquire new ideas and think critically about models for sustainable agriculture (Slijper et al., 2022).

Unfortunately, the level of formal cooperation between farmers in developing countries remains very low due to lack of trust in cooperative institutions, organizational immaturity, large numbers of farmers and limited commercial orientation (Muriqi et al., 2019). This low level of formal cooperation may also be due to weak managerial capital (Francesconi et al., 2021).

Studies show that cooperation between farmers in developing countries takes place mainly through informal mutual aid networks (Hoang et al., 2006; Zhou, 2021). Although these mutual aid networks

are assimilated to a form of informal cooperation between farmers (Dessie et al., 2019; Wedajo and Jilito, 2020) some authors have pointed out that they play an important role in the survival of small farms and can serve as channels for the dissemination of agricultural innovations (Wulandhari et al., 2022). The positive influence of mutual aid has also recently been highlighted in the adoption of innovative techniques in urban agriculture in Lubumbashi (Nsele et al., 2022).

Informal mutual aid networks also play a role in developing and mediating adaptation practices, and have the potential to facilitate collective experimentation and even risk management, thus contributing to the resilience and sustainability of the socio-ecological system (Rodima-Taylor, 2012). The essence of mutual aid manifests itself on the one hand through the mobilization of social forces such as neighborhoods and volunteers, and on the other through the optimal use of the free time of various human resources and low-cost services (Zhou, 2021).

For some authors, mutual aid between small farmers can focus on two main aspects, namely the collective sharing and development of know-how, which optimizes local production systems (Robert, 2022) and resource sharing, which improves farmers' access to scarce resources such as land, labor, equipment, inputs and informal financing (Sutherland and Burton, 2011; Lutz et al., 2017).

In the DRC, the agricultural code, which is the fundamental law for the agricultural sector, aims to establish a harmonious and supportive framework between agricultural cooperatives, farmers' associations, non-governmental organizations, the State, and its services, with a view to creating profitable and sustainable relationships. As such, farmers should belong to formal organizations with notarized statutes (Ministère de l'Agriculture, 2008). Unfortunately, the country's cumbersome bureaucracy, the financial obligations associated with these formal organizations and the lack of consideration they receive from the state force farmers to cooperate instead in informal networks (Chuma et al., 2022).

In addition, it appears that Congolese small-scale farmers are increasingly distrustful of formal organizations due to the existence of conflicts arising from the selfishness of the leaders of these organizations in sharing the benefits. These conflicts have led to the dysfunction, or even disappearance, of most formal organizations. This explains why the vast majority of farmers turn to informal mutual aid networks for mutual support (Nsele et al., 2022). This aspect is reminiscent of the issues linked to power relationships and governance mechanisms highlighted by work on agricultural cooperatives and the sharing of value between their various members (De Herde et al., 2020). An additional difficulty arises more specifically in relation to the inclusion of farmers from small farms within large cooperatives (Bijman and Wijers, 2019).

## 2.2. Study area

Lubumbashi is located at 027°48'61"1 longitude East, 11° 61'55 3" latitude South, at an altitude of 1,257 m. The city comprises 43 districts in 7 communes: Kampemba, Katuba, Kenya, Kamalondo, Ruashi, Lubumbashi and Annexes (Mutangala et al., 2021). Urbanized areas are characterized by an urban zone (high proportion of continuous built-up areas) in the city center, linked to a peri-urban zone

(discontinuous with a low proportion of built-up areas) resulting from the extension of built-up areas in rural areas (Useni et al., 2022).

Lubumbashi records a humid subtropical climate (Cw type of the Köppen classification system) (Sikuzani et al., 2021). This climate is characterized by a rainy season (November to March), a dry season (May to September) and two transitional months (April and October). Annual rainfall is 1,270 mm, with extremes of 717 and 1770 mm, and the mean annual temperature is around 20°C (minimum 8°C and maximum 32°C) (Mujinya et al., 2011). Lubumbashi's soils are acidic and belong to the Ferralsol group of soils considered poor. There are also hydromorphic soils (considered rich) in the valley bottoms, where urban agriculture is mainly practiced. However, the cultivation of these soils, combined with poor farming practices, has led to the collapse of their physical, chemical and biological fertility (Kasongo et al., 2013). Worse still, these soils accumulate waste enriched with heavy metals from the mineral processing plants installed in the city of Lubumbashi (Mpundu et al., 2013). The city was hard hit by the crisis of the 1990s, which led to the collapse of the mining industry and, more generally, its entire wage sector (Petit and Mutambwa, 2005). To survive, Lubumbashi's poor resort to urban agriculture (Tambwe et al., 2011).

Furthermore, urban agriculture in Lubumbashi is managed by the National Service for Urban and Peri-urban Horticulture, which specializes in this field within the provincial Ministry of Agriculture and Rural Development. There is also a Communal Consultation Committee chaired by the Mayor of Lubumbashi, made up of the mayors of each municipality, a representative of the ministries of land affairs and customary law, and members of producers' associations and private farmers. This committee is responsible for mobilizing the various services and skills required for the sustainable development of the agricultural sector (Mutshail, 2014).

Moreover, farmers are also grouped together within the Committee of Market Gardeners of Lubumbashi, created in 2004 to support farmers' associations. Unfortunately, the inefficiency of the institutional framework for supporting the agricultural sector in the DRC means that these services cannot function properly (Mutshail, 2014). Furthermore, urban agriculture in Lubumbashi remains a marginalized sector, as municipal authorities and city dwellers portray it as a sign of rurality 'displaced' to urban areas and, at best, as a response to poverty (Peša, 2020). These narratives have distorted the understanding of urban agriculture. Farmers' only motivation remains household survival, hence common expressions in Lubumbashi such as "Instead of begging, I farm to feed my children" (Tambwe et al., 2011). Consequently, urban agriculture is still associated with poor production practices, farms are less profitable (Kesonga, 2017) and critical levels of heavy metals are reported in market garden produce (Mununga et al., 2023).

Urban agriculture in Lubumbashi is mainly based on monoculture production of Chinese cabbage (*Brassica chinensis* L.). The latter belongs to the Brassicaceae family (Bajkacz et al., 2021). Chinese cabbage is grown for its leaves and is the most widely consumed vegetable in Lubumbashi during the dry season, when it is sold at low prices (Kesonga, 2017). The main components of the technical itinerary for Chinese cabbage include nursery work, soil preparation based mainly on the installation of beds, direct sowing or transplanting of seedlings, the application of plant protection products, the application of fertilisers and the sale of standing vegetables. Chinese cabbage is grown at a density of 20 cm × 20 cm (Nsele et al., 2022).

## 2.3. Sites selection and farmers

The seven sites (Figure 1) chosen to carry out the present study were selected considering the criteria pre-established during our previous survey in the same study area. The 88 farmers selected (Table 1) for this study were randomly drawn from 202 farmers previously surveyed in April and August 2020 (Nsele et al., 2022). To examine the representativeness of this sample, we compared the socio-economic data of our survey sample with those of our exploratory survey conducted in April and August 2019 among 279 individuals in the target area. Indeed, this was the only source of comparison available.

In addition, the exploratory survey gathered information on the socio-demographic, economic and institutional characteristics of the farmers, as well as information on the characteristics of their farms, such as the start-up period of market gardening activities, the main crops grown, the areas farmed, the number of production cycles per year, the production factors used, the production costs per production cycle, the income earned and the main constraints of urban market gardening. At present, this exploratory survey constitutes the largest survey carried out on urban agriculture in Lubumbashi, i.e., there is no other larger statistical source.

As the only reference is the exploratory survey, to demonstrate the representative statistical validity of the sub-sample, we have assumed that the farmers in the sub-sample are considered comparable to those usually found in market gardens in Lubumbashi. By comparing the characteristics of the farmers in the sub-sample with those of the farmers in the exploratory survey, we can determine the representativeness of the sample and possibly highlight certain differences.

## 2.4. Collection data

During the survey specifically dedicated to the question of mutual aid, the 88 farmers were interviewed individually in their farms, using a structured questionnaire. They were asked to answer the following question: Have you resorted to mutual aid during the current production cycle? Farmers who said they had used mutual aid were asked about aspects of the help they had received, the social ties they had mobilized to help each other, and the number of farmers in mutual exchange networks. In addition, farmers who said they had not used mutual aid were asked why they had not.

Furthermore, farmers were asked to provide information on their socio-demographic, economic and institutional characteristics, including the characteristics of their farms. Throughout this in-depth survey, direct observations of farmers' practices were carried out to better identify the stage in the production process when the farmer deemed it necessary to resort to mutual aid, as well as the nature of the help received. The in-depth survey covered the period from April to August 2021. This period was chosen for one simple reason: it is the period when urban agriculture is widely practiced in Lubumbashi.

To deepen our understanding of mutual aid and its specific motivations, a series of unstructured interviews was conducted with 15 farmers between August and September 2022. This period was chosen for a simple reason: it is the closing period of urban agriculture activities in Lubumbashi, and farmers could better testify to the practice of mutual aid by drawing on the experience gained during the agricultural season. The aim of these interviews was to gather farmers' views on the reasons why some of them resort to



## 2.5. Data analysis and processing

The quantitative data collected during the present study were processed using Minitab statistical software, version 21.1.1. Mutual aid was treated as a binary qualitative variable: having used mutual aid (1) or not having used it (0). The chi-square adjustment test ( $X^2$ ) was applied to check whether the characteristics of farmers in the sub-sample follow the normal distribution compared with the characteristics of farmers in the large exploratory survey sample. The aim was therefore to verify the representativeness of the sub-sample in relation to all urban farmers in Lubumbashi. Descriptive analysis was used to present qualitative variables (numbers and percentages) and quantitative variables (mean plus or minus standard deviation). The chi-square test ( $X^2$ ) was used to identify the socio-demographic, economic and institutional characteristics of farmers likely to motivate their decision to use or not mutual aid. The study considered an  $\alpha$  value  $<0.05$  to be statistically significant.

Farmers' socio-economic variables (such as gender, age, education, marital status, experience, religious affiliation, farming origin, farmer's status in the household), economic variables (such as land status, farm size, diversification of income sources) and institutional variables (such as membership of an association, contact with extension services, access to training and access to credit) were mobilized for statistical tests related to mutual aid.

## 3. Results

In this section, we present the results of the quantitative survey and extracts from farmers' testimonies on mutual aid.

### 3.1. Characteristics of farmers

The results presented in [Table 2](#) show that, overall, 12 out of 15 variables (i.e., almost all variables relating to the socio-demographic, economic and institutional characteristics of farmers in the sub-sample specifically dedicated to the question of mutual aid) are like the characteristics of farmers in the large exploratory survey sample for these variables. The Chi-square adjustment test shows non-significant differences. Given the results of the Chi-squared adjustment test, we can consider that our sub-sample is representative of all farmers in Lubumbashi and can be used for statistical analysis. On the other hand, significant differences are reported for three farmer characteristics. The sub-sample shows an increase in the proportion of inexperienced farmers and those who have been in contact with the extension service, and a decrease in farmers affiliated to religious denominations. Variations in the three farmer characteristics are inevitably linked to the rest of the characteristics. For example, being a young farmer, like most of our survey respondents, may increase the likelihood of being inexperienced.

### 3.2. Characteristics of farmers in relation to mutual aid

The results ([Table 3](#)) show that 79.5% of farmers surveyed had used mutual aid. During our more in-depth interviews, some farmers

stated that, given their precarious position in the face of poverty and the inoperative nature of the institutional framework supporting urban agriculture, mutual aid enables them to compensate for shortfalls in production resources and agricultural know-how. At present, they see mutual aid as an indispensable lever in farm management, without which it is very difficult, if not impossible, to successfully complete an agricultural production cycle and ensure the survival of their household. Furthermore, characteristics such as gender, age, experience, religious affiliation, and the farmer's status in the household were the explanatory and significant factors in whether they practiced mutual aid. On the other hand, factors such as level of education, marital status and whether the farmer is indigenous or non-indigenous to Lubumbashi do not appear to be statically significant in explaining the use or non-use of mutual aid. Some women have reported that, when unemployed men (usually their husbands) get involved in urban agriculture, they tend to forbid their wives to resort to informal mutual aid networks, for fear of being exposed to male covetousness or possible conflict. This may explain the low participation of women in informal mutual aid networks.

The results in [Table 4](#) show that farmers with diversified incomes seem less inclined to resort to mutual aid. On the other hand, land status and farm size are not statistically significant explanatory factors for mutual aid.

Surprisingly, compared with the literature, the results in [Table 5](#) show that none of the institutional factors is statistically significant in explaining the use or non-use of mutual aid. This may be justified by the inoperative nature of the institutional/organizational framework supporting urban agriculture in Lubumbashi, our results showing, for example, the low number of farmers who are members of an association.

### 3.3. Aspects of mutual aid mobilized by farmers

The results in [Table 6](#) show that, overall, in terms of exchanges of production resources, over the course of a production cycle, a farmer exchanges on average 15.1 times with other farmers. According to the nature of the resources exchanged, the results show that 49.7% of exchanges concern equipment such as hoes and watering cans, 38.4% inputs (phytosanitary products, chicken droppings and seeds), and 11.9% land capital and agricultural equipment such as motor pumps, spades, and buckets. On the other hand, resources such as financing, labor, and chemical fertilizers (urea and NPK) are not traded. During our interviews, most farmers claimed that the role played by the hoe and watering can is inescapable. It is impossible to have a successful production cycle without them, as they can compensate for the need for other equipment. The hoe, for example, can be used for several tasks, including stumping, bed-making, sowing, and weeding, while the watering can may be used for watering, spraying and sprinkler fertigation. A 61-year-old farmer interviewed in Kashamata said that, at present, young people come to do market gardening without equipment and that they rely on their help to make a successful crop cycle. In addition, the presence of young farmers on market gardening sites is very important, as they help the older ones with the heavy tasks and pass on old practices. According to this farmer, market garden sites are thus places of great conviviality, clearly defined by mutual aid. In addition, equipment such as hoes and watering cans

TABLE 2 Socioeconomic characteristics of farmers.

Variables	Characteristics	Modalities	Exploratory survey	In-depth survey	Value of $p(X)^2$
Socio-demographic	Gender	Male	122 (43.7)	41 (46.6)	0.588
		Female	157 (56.3)	47 (53.4)	
	Age	Young: $\leq 45$ years old	188 (67.4)	64 (72.7)	0.285
		Oldest $> 45$ years	91 (32.6)	24 (27.3)	
	Study	Educated	267 (95.7)	85 (96.6)	0.680
		Uninstructed	12 (4.3)	3 (3.4)	
	Marital status	Married	219 (78.5)	62 (70.5)	0.066
		Unmarried	60 (21.5)	26 (29.5)	
	Experience	Short $\leq 10$ years	190 (68.1)	78 (88.6)	0.000***
		Long $> 10$ years	89 (31.9)	10 (11.4)	
	Religious affiliation	Affiliated	266 (95.3)	73 (83)	0.000***
		Unaffiliated	13 (4.7)	15 (17)	
Farmer's origin	Native	155 (55.6)	46 (52.3)	0.921	
	Non-native	124 (44.4)	42 (47.7)		
Household status	Head of household	157 (56.3)	53 (60.2)	0.455	
	Not chief	122 (43.7)	35 (39.8)		
Economic	Land status	Owner	110 (39.4)	29 (33)	0.214
		Tenant	169 (60.6)	59 (67)	
	Farm size	Small: $\leq 4$ ares	189 (67.7)	64 (72.7)	0.317
		Large: $> 4$ ares	90 (32.3)	24 (27.3)	
Diversification of revenue sources	Yes	25 (9)	15 (17)	0.008	
	No	254 (91)	73 (83)		
Institutional	Join an association	Yes	86 (30.8)	31 (35.2)	0.371
		No	193 (69.2)	57 (64.8)	
	Contact with extension	Yes	151 (54.1)	61 (69.3)	0.004*
		No	128 (45.9)	27 (30.7)	
	Access to training	Yes	152 (54.5)	55 (62.5)	0.131
		No	127 (45.5)	33 (37.5)	
	Access to credit	Yes	34 (12.2)	9 (10.2)	0.574
		No	245 (87.8)	79 (89.8)	

Number of observations in exploratory survey = 279; number of observations in in-depth survey = 88; percentage in brackets, value of  $p(X^2)$  = Chi-square test of fit (one variable), \* indicates significant test at 5%, \*\*\* indicates very highly significant test at 5%.

are often acquired thanks to donations from development aid projects, NGOs, churches, and politicians. Unfortunately, it appears that such donations are decreasing, and young people find it difficult to acquire the equipment they need, thereby rendering mutual aid more critical.

Furthermore, the same results in Table 6 show that, depending on the number of farmers involved in mutual aid and the relationships a farmer has with these colleagues via the resources exchanged during a production cycle, four categories of resources are defined. These are (i) highly exchanged resources with a high exchange intensity (hoes, watering cans, plant protection products and chicken droppings), (ii) highly exchanged resources with a low exchange intensity (land capital, spades, and seeds), (iii) resources with a low exchange intensity (motor pumps and buckets) and (iv) non-exchanged resources (financing, labor, chemical fertilizers).

The results in Table 7 show that, overall, in terms of exchanges of agricultural know-how, over the course of a production cycle, a farmer exchanges know-how with other farmers an average of 11.6 times. According to the nature of the know-how exchanged, the results show that 46.6% of exchanges concern soil fertility management know-how and soil preparation techniques, 29.3% concern watering, sowing and weeding techniques, 14.6% concern crop protection techniques and 9.5% concern vegetable sales methods.

Furthermore, the same results in Table 7 show that, except for know-how sharing on sowing and weeding techniques, which are highly exchanged but of low intensity, all other techniques, such as those relating to fertility management, soil preparation, pest control and sales, are highly exchanged and of high intensity.

During our in-depth interviews with farmers, some of them stated that they were faced with a lack of autonomy in terms of

TABLE 3 Socio-demographic characteristics of farmers in relation to mutual aid.

Characteristics of farmers	Mutual aid			X <sup>2</sup> -test (Pearson)	Value of p
	Yes	No	Total		
Type					
Male	38 (92.7)	3 (7.3)	41 (100)	8.143	0.004**
Female	32 (68.1)	15 (31.9)	47 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		
Age					
Young: ≤45 years old	58 (90.6)	6 (9.4)	64 (100)	17.705	0.000***
Oldest >45 years	12 (50)	12 (50)	24 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		
Education level					
Educated	67 (78.8)	18 (21.2)	85 (100)	0.799	0.371
Uninstructed	3 (100)	0 (0)	3 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		
Marital status					
Married	49 (79)	13 (21)	62 (100)	0.034	0.854
Unmarried	21 (80.8)	5 (19.2)	26 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		
Experience					
Short ≤10 years	65 (83.3)	13 (16.7)	78 (100)	6.053	0.014*
Long > 10 years	5 (50)	5 (50)	10 (100)		
Total	75 (79.5)	18 (20.5)	88 (100)		
Religious affiliation					
Yes	65 (89)	8 (11)	73 (100)	23.733	0.000***
No	5 (33.3)	10 (66.7)	15 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		
Farmer's origin					
Native	36 (78.3)	10 (21.7)	46 (100)	0.098	0.755
Non-native	34 (81)	8 (19)	42 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		
Household status					
Head of household	46 (86.8)	7 (13.2)	53 (100)	4.301	0.038*
Not head of household	24 (68.6)	11 (31.4)	35 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		

Number of observations in in-depth survey = 88; X<sup>2</sup>, Chi-square test; percentage in brackets; \* indicates significant test at 5%, \*\* indicates highly significant test at 5%, \*\*\* indicates very highly significant test at 5%.

production equipment and uncertainty as to the choice of appropriate production techniques. A 19-year-old farmer interviewed in Tingi-Tingi said that urban agriculture was his main activity, enabling him to contribute to the survival of his poverty-stricken household and cover his school fees. However, he did not own any farming equipment. To produce, he must ask for help with equipment and know-how from the more experienced farmers on his production site, whom he considers to be his father and mother. He also uses equipment left by sick or deceased farmers. However, this young farmer points out that asking for more help destroys his self-esteem and can lead to conflict if the equipment he asks for is lost or destroyed. He hopes that 1 day, public urban agriculture services and development support projects will be able to step in and provide him with the training and equipment he needs to become autonomous.

Figure 2 shows the distribution of the 70 respondents who were asked to choose just one of the three social ties most frequently mobilized to help each other. Neighborhood relations were cited by 40% of farmers surveyed, kinship relations by 32.9% and belonging to the same religious denomination by 27.1%.

## 4. Discussion

### 4.1. Characteristics of farmers in relation to mutual aid

The results show that 79.5% of the surveyed farmers had to resort to mutual aid during a production cycle. This result is in line with a

TABLE 4 Economic characteristics of farmers in relation to mutual aid.

Characteristics of farmers	Mutual aid			X <sup>2</sup> -test (Pearson)	Value of p
	Yes	No	Total		
Land status					
Owner	22 (75.9)	7 (24.1)	29 (100)	0.361	0.548
Tenant	48 (81.4)	11 (18.6)	59 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		
Farm size					
Small: ≤4 ares	52 (81.3)	12 (18.8)	64 (100)	0.419	0.517
Oldest >45 years	18 (75)	6 (25)	24 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		
Diversified sources of income					
Yes	3 (20)	12 (80)	15 (100)	39.404	0.000***
No	67 (91.8)	6 (8.2)	73 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		

Number of in-depth survey observations = 88; X<sup>2</sup>, Chi-square test; percentage in brackets; \*\*\* Indicates a very highly significant test at 5%.

TABLE 5 Institutional characteristics of mutual aid farmers.

Farmer characteristics	Mutual aid			X <sup>2</sup> -test (Pearson)	Value of p
	Yes	No	Total		
Association membership				0.036	0.850
Yes	25 (80.6)	6 (19.4)	31 (100)		
No	45 (78.9)	12 (21.1)	57 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		
Contact with extension services				0.075	0.784
Yes	49 (80.3)	12 (19.7)	61 (100)		
No	21 (77.8)	6 (22.2)	27 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		
Access to training				2.254	0.133
Yes	41 (74.5)	14 (25.5)	55 (100)		
No	29 (87.9)	4 (12.1)	33 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		
Access to credit				0.019	0.890
Yes	7 (77.8)	2 (22.2)	9 (100)		
No	63 (79.7)	16 (20.3)	79 (100)		
Total	70 (79.5)	18 (20.5)	88 (100)		

Number of observations in in-depth survey = 88; X<sup>2</sup>, Chi-square test; percentage in brackets.

study showing that mutual aid reduces the risks associated with agricultural production, particularly for small farmers with few resources (Keeley et al., 2019).

The results of our survey show a high representation of young people in urban agriculture in Lubumbashi [67.4%, slightly accentuated in the in-depth survey sample (72.7%)], and that being young is an explanatory factor for the practice of mutual aid. Authors such as Ouko et al. (2022) assert that rising unemployment in the cities of developing countries is forcing young people to turn to informal income-generating activities, such as urban agriculture. Similarly, in Cameroon, with lucrative activities saturated in both the formal and informal sectors, poverty is reaching worrying levels, endangering 30% of the population of the city of Yaoundé. To survive,

unemployed young people are forced to take up urban agriculture, exploiting the swampy lowlands and public spaces available in urban areas (Sogang and Monkouop, 2022). In Africa, urban agriculture has indeed been shown to reduce poverty and food insecurity (Adenle et al., 2019).

However, in a context of chaotic urbanization of cities in developing countries, access to urban agriculture remains largely limited by the high cost of land capital (Nchanji and Nchanji, 2022; Al Raei, 2023). Unplanned urbanization hampers urban agriculture through intense competition for land between developers and farmers (Abdulai, 2022). Authors such as Fischer et al. (2020) argue that land competition creates gender and generational inequalities. These inequalities exacerbate the difficulties faced by marginal urban

TABLE 6 Sharing production resources.

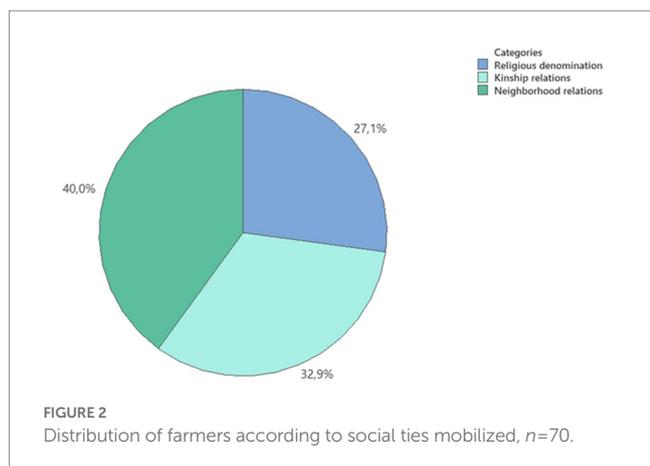
Main production factors	N	Exchange intensity
Land capital	37	1 (0.1)
Financing	0	–
Workforce	0	–
Hoe	70	4.1 (1.3)
Motor pump	20	1.1 (0.3)
Watering can	50	4.8 (1.4)
Buckets	24	1.1 (0.3)
Spade	37	1.1 (0.3)
Seeds	55	1.4 (0.6)
Crop protection products	54	3.2 (1.6)
Urea	0	–
NPK	0	–
Chicken droppings	49	3.1 (1.4)
Weighted average 15.1		

Number of observations of farmers having mobilized forms of mutual aid = 70; N, number of farmers in the sample having mobilized mutual aid on the resource concerned. Exchange intensity represents the number of exchanges a farmer has had with other farmers, standard deviation in brackets. This does not necessarily correspond to the number of farmers with whom exchanges took place, as different aspects can be exchanged with the same farmer.

TABLE 7 Sharing know-how.

Variables	N	Exchange intensity
Soil preparation	48	2.5 (1.5)
Seeding techniques	55	1.4 (0.5)
Watering techniques	51	2.1 (0.8)
Soil fertility management	56	4.6 (1.1)
Crop protection	54	2.2 (1.3)
Weed control	49	1.1 (0.3)
How to sell	53	1.5 (0.6)
Weighted average 11.6		

Number of observations of farmers having mobilized forms of mutual aid = 70; N, number of farmers in the sample having mobilized mutual aid on the know-how concerned. Exchange intensity represents the number of exchanges a farmer has had with other farmers. It does not necessarily correspond to the number of farmers with whom exchanges took place, as different aspects can be exchanged with the same farmer.



communities in developing countries (women and young people) in gaining access to production resources (Meinzen-dick et al., 2014; Ingutia and Sumelius, 2022).

Typically, young urban dwellers adopt urban agriculture for lack of other survival options, and thus face numerous problems (Tambwe et al., 2011). For example, difficulties of access to land (Sogang and Monkouop, 2022) lack of knowledge and experience (Ding and Kinnucan, 2011) financial challenges and lack of access to credit (Eistrup et al., 2019; Jablonski et al., 2022). These numerous difficulties encountered by young farmers are likely to limit the performance of their farms, which may explain their reliance on informal mutual aid networks, particularly with their elders in order to ensure the survival of their farms and households (Jansuwan and Zander, 2022; Nsele et al., 2022).

Over time, the performance of young farmers' farms is associated both with an increase in their size and productivity, and with their strong involvement in sociocultural activities (Jablonski et al., 2022). The farms of young farmers are more likely to have resource requirements than those of older farmers. This may explain the strong involvement of young people in informal mutual aid networks (Jansuwan and Zander, 2022). Young farmers appear to often turn to their elders in order to overcome the multiple constraints associated with production (Tangtong et al., 2022).

Our results also show that farmers affiliated to a religious denomination made greater use of mutual aid than those not belonging to any religious denomination. This can be justified by the simple fact that, outside public spaces, most farmers farmland belong to churches of which being a member strengthens the social ties through prayer groups and thus facilitates mutual aid.

Our results also show that farmers with head-of-household status were more likely to resort to mutual aid. During our in-depth interviews, one farmer heading a household of 8 members stated that vegetable production was his household's main source of income. Unfortunately, the income from this activity does not cover the household's basic needs, let alone those related to running the farm. Recourse to mutual aid in this context, amplified by the inefficiency, or even absence, of the institutional framework supporting agriculture, remains an indispensable support to ensure production and survival. This echoes a study carried out in Zimbabwe, which revealed that, in the absence of public social assistance, poor urban households facing idiosyncratic shocks rely heavily on networked households and informal groups and, to a lesser extent, donors (Dafuleya et al., 2021).

Our results reveal that only one economic factor is statically significant in explaining whether farmers engage in mutual aid. Indeed, farmers who do not have diversified sources of income are more likely to practice mutual aid. It should be noted that diversification of income sources has always been advocated by development support projects as well as by scientific research, which sees it as a means of ensuring the self-sufficiency of poor households and their farms (Gugissa et al., 2022; Vernoooy, 2022). This aspect is therefore confirmed in our analysis, which seems to indicate that mutual aid is unavoidable in the absence of diversified sources of income.

Another important insight from the survey is that no institutional factor appears statistically significant in explaining the practice of mutual aid. The institutional framework for urban agriculture in Lubumbashi is headed by the National Service for Urban and Peri-urban Horticulture, specialized in this field within the Ministry of

Agriculture and Rural Development. There is also a Municipal Consultation Committee chaired by the city's mayor, responsible for (i) mobilizing the various services and skills required for the sustainable development of urban agriculture, (ii) managing the land access process and (iii) integrating the activity into the urban development plan. Farmers are grouped within the Lubumbashi Market Gardeners Committee, created in 2004 to support farmers' associations (Mutshail, 2014).

Although several farmers' associations exist thanks to the support of the Lubumbashi urban and peri-urban horticulture project, our survey shows that only a minority of farmers (30.8 or 35.2 for the reduced sample) are members of the associations in question. Some authors have made the same observation (Ntumba et al., 2015). One study revealed that Lubumbashi's farmers' associations currently exist in name only. Farmers are no longer members because the leaders of these associations are accused of being selfish in sharing the donations they receive. This leads to conflict and mistrust, with the result that most of the associations are dysfunctional or even closed. Instead, these farmers rely on informal mutual aid networks (Nsele et al., 2022).

## 4.2. Aspects of mutual aid mobilized by farmers

In agriculture, mutual aid can relate to various aspects, such as the collective sharing and development of know-how and/or the sharing of scarce resources (Vansant et al., 2022). Our results also show that farmers in Lubumbashi use these two forms of mutual aid. Furthermore, resources such as hoes and watering cans are widely exchanged because of their essential role in monitoring technical itineraries, and because they can be used by several farmers during the same cropping cycle. Studies have shown that in developing countries, the agricultural tasks involved in urban market gardening are extremely arduous, as they are generally carried out by hand, using hoes and watering cans, which are the main farming equipment (Mhache and Lyamuya, 2019; Tiwari et al., 2022).

Furthermore, phytosanitary products are heavily exchanged due to the severity of the damage caused by pests and the proximity between two or more market garden farms. In Lubumbashi, farmers opt for simultaneous spraying of surrounding gardens, obviously in agreement with their owners, in order, they say, to limit the spread of pests. One study claims that the cutworm "*Agrotis ipsilon* L" is the most dangerous pest in Chinese cabbage production in Lubumbashi (Mushagalusa and Nkulu, 2020). Authors such as Mekonnen et al. (2022) assert that the proximity of farms facilitates various forms of exchange between farmers.

Chicken droppings are heavily traded due to the drastic decline in soil fertility levels, farmers' insufficient knowledge of composting techniques, low costs and the psychosocial barriers associated with acquiring these droppings. Overall, soils in the Lubumbashi region are considered poor in terms of fertility (Kasongo et al., 2013). Although urban agriculture is practiced on hydromorphic valley-bottom soils, which are reputed to be rich in fertility (Atibu et al., 2016) their cultivation leads to an accelerated reduction in organic matter content, resulting in a collapse of their chemical, biological and physical fertility. In addition, due to their topographical position, valley bottom soils accumulate waste enriched with heavy metals from ore processing plants installed in and around Lubumbashi (Mpundu et al.,

2013). Authors such as Mpundu et al. (2014) demonstrate that organic soil improvers sustainably improve soil fertility and limit the mobility of heavy metals.

One study points out that, due to a lack of knowledge of composting techniques, market gardeners in Lubumbashi resort to chicken droppings, which they obtain at low cost or even free of charge from breeders scattered around the city. However, older farmers find it difficult to make long journeys in search of chicken droppings, and young, generally well-educated people are reluctant to roam the city with bags of droppings on their heads, for reasons linked to the preservation of self-esteem, in the face of the poor opinions that city dwellers have of urban agriculture (Nsele et al., 2022). According to one study, government officials, city dwellers and social scientists present urban agriculture as a sign of rurality "displaced" to urban areas, at best as a response to poverty and crisis, or as a practice reserved for "thrifty housewives." These narratives have distorted our understanding of urban agriculture (Peša, 2020).

Thus, chicken droppings can be traded between young farmers willing to overcome psychosocial barriers to offset the costs of chemical fertilizers and older farmers, and in other cases between farmers willing to bear the costs associated with transporting droppings and those willing to collect droppings from breeders.

Land capital is highly traded and of low intensity, because in a context of chaotic urbanization, land is a scarce and expensive commodity (Nkosi et al., 2022). So, insofar as a farmer may own land and wish to help other farmers, he will only be able to help one of the many farmers looking for land. Once transferred, land can only be exchanged at the end of the production cycle, which may limit its propensity for mutual aid, unlike other resources which can be exchanged during a production cycle. It can also happen in some cases that farmers cannot access land because it has been acquired by people who care little about farming, and the land goes unused (Fajobi et al., 2022).

According to one interviewed farmer, most farmers who own land do not have title deeds. They are therefore reluctant to help each other for fear of being swindled. Similarly, land conflicts linked to spoliation and the demarcation of farms are a real scourge that hampers social peace in market garden areas. Numerous studies show that land pressure is a universal constraint on urban agriculture (Royer et al., 2023; Sumbo et al., 2023).

Resources such as motor-driven pumps and buckets are little traded and of low intensity due to their low level of use. One study points out that small urban producers water their crops manually using watering cans (Mawois et al., 2011). Authors such as Nsele et al. (2022) reported that only 25.2% of urban farmers in Lubumbashi had used motor pumps during a Chinese cabbage production cycle, and that farmers' access to motor pumps was based on group purchase. Most farmers (74.8%) water their crops manually with watering cans.

Resources such as finance, labor and chemical fertilizers are not traded. This may be explained by farmers' difficulties in accessing finance (Deresse and Zerihun, 2018) and the high price of chemical fertilizers (Liu and Gang, 2022). The low level of labor exchanges at the mutual aid level can be justified by the fact that small producers often opt for family labor, which is generally available, and that, failing to call on outside labor, they reciprocally perform tasks on the farms, or they decide to pay the labor.

One study highlights the potential of collective know-how sharing and development to optimize local farming systems. However, farmers

often lack the knowledge and time to establish formal collaborations within associations and reorganize work, logistics and communication processes (Lutz et al., 2017). Authors assert that technical know-how is channeled through informal networks of mutual aid between farmers (Hoang et al., 2006).

Unfortunately, studies show that the cultivation techniques used by farmers in Lubumbashi, such as integrated soil fertility management, which combines chemical fertilizers with chicken droppings and is only practiced by 58.4% of farmers (Nsele et al., 2022) and those of crop protection based on the abusive and unprotected use of phytosanitary products, only accelerate soil degradation (Kesonga, 2017) exposing farmers to enormous health risks (Mengistie et al., 2017; Sookhtanlou et al., 2022) and alter the quality of vegetables in terms of heavy metal content (Mununga et al., 2023). Hence the need to train farmers in sustainable production techniques, in the context of the impacts of climate change, which are already exacerbating the uncertainties of small-scale producers (Abid et al., 2019).

Our results reveal that farmers mobilize social ties such as good neighborliness, kinship, and religious affiliation to help each other. These results are consistent with those found by Wedajo and Jilito (2020). Other authors add that factors such as ethnic origin, socio-cultural status and power relations influence farmers' access to information (Hoang et al., 2006). In our in-depth interviews, some farmers stated that, in addition to their indispensable importance to farm and household survival, farmer-to-farmer exchanges also ensure social cohesion and access to a variety of useful information such as political, religious and security communications. Some studies have emphasized that information sharing between farmers remains more relevant than ever, particularly with regard to their role in the emergence of innovative techniques and technologies (Nakasone and Torero, 2016; Omulo and Kume, 2020).

In addition, our results have enabled us to understand the crucial role of informal mutual aid networks in maintaining farms and the survival of farming households in a period of chaotic urbanization, ineffective institutional frameworks, and widespread climate change. The strong mutual aid dynamics revealed by our results in these informal mutual aid networks constitute powerful and inexpensive communication channels, likely to ensure the dissemination of agricultural innovations to small urban producers. This finding will be useful for implementing policies and strategies aimed at improving the agricultural productivity of small-scale urban producers by promoting agricultural innovations.

## 5. Conclusion

This paper examines how urban farmers in Lubumbashi are compelled to mobilize social ties to support each other to face of the multiple constraints of urban agriculture, and thus ensure the survival of their farms and households. The study deciphered the dynamics of mutual aid in an urban farming context characterized by the arrival of many young farmers.

The data collected through the exploratory survey show that urban agriculture in Lubumbashi is practiced by young people (67.4%) who are women (56.3%), married (78.5%), inexperienced (68.1%), and for whom urban agriculture is the main survival activity (91%). Furthermore, these farmers are not members of producers'

associations (69.2), have no access to credit (87.8) and rent land (60.6%). These farmer characteristics are important in explaining their propensity to resort to mutual aid.

Furthermore, the results of our in-depth survey do indeed show that this propensity is high as 79.5% of the surveyed farmers resort to mutual aid for ensuring the success of their crop cycle. This mutual aid involves two aspects: the sharing of production resources, where the farmer meets other farmers 15.1 times, and the sharing of agricultural know-how, where the farmer meets other farmers 11.6 times.

Our results distinguish four categories of resources in this mutual aid network: highly exchanged but exchange-intensive resources (hoes, watering cans, crop protection products and chicken droppings), highly exchanged but exchange-intensive resources (land capital, spades, and seeds), lightly exchanged and exchange-intensive resources (motor pumps and buckets) and non-exchanged resources (financing, labor, chemical fertilizers). In addition, agricultural know-how such as soil preparation techniques, soil fertility management, pest control and vegetable sales are widely shared. These results highlight the need to support and mentor young farmers to enable them to become self-sufficient in production resources and agricultural know-how, to envisage the development of cities in developing countries through sustainable local agriculture.

Our results also show that relationships with neighbors, relatives and religious affiliations are identified by farmers as social ties used to help each other. Some farmers pointed out that excessive demand for help destroys self-esteem and can lead to conflict in the event of loss or destruction of requested equipment. In addition, farmer characteristics such as gender, age, experience, religious affiliation, and the farmer's status in the household are statistically significant factors for explaining the practice of mutual aid. Furthermore, farmers with diversified incomes seemed less inclined to resort to mutual aid.

Given the high intensity of mutual aid between farmers, the study recommends that policymakers, extension agents and development projects take mutual aid networks into account when drawing up policies for the dissemination of agricultural innovations. For, although informal, these networks have proved to be powerful and inexpensive channels of communication between smallholders within the inoperative institutional framework of urban agriculture. It is therefore important to analyze these informal mutual aid networks in greater depth, in terms of the modalities of mutual aid, and of the governance and access to these informal networks.

## Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

## Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

## Author contributions

MK, TD, and KM: conceptualization, methodology, formal analysis, preparation of the initial draft, and revision and editing of the draft. TD and KM: validation. MK: survey. TD and KM: supervision. All authors have read and agreed to the published version of the manuscript.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2023.1248937/full#supplementary-material>

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