

Why is there a shortage of agricultural labor in Algeria? Evidence from M'zirâa, southern Algeria's leading vegetable market

MAROUANE CHAAMI*, SLIMANE BEDRANI*, ABDELWAHAB BESSAAD**,
FATIMA LAMBARRAA-LEHNHARDT***

DOI: 10.30682/nm2501h

JEL codes: J24, J42, J43, Q10

Abstract

The amplification of labor shortages has become an inescapable reality for many Algerian farmers in recent years. To study this issue, systemic surveys were conducted in 125 farms in the vegetable crops pole of M'zirâa (southern Algeria). A labor shortage is reported on 56.80% of farms. The primary causes, as identified by respondents, are poor working and living conditions (76.67%) and low wages, which are considered insufficient by both workers and new settlers (70.67%). On the other hand, employment opportunities in the tertiary sector offer more interesting incomes compared to agricultural activity, which is becoming less remunerative and less attractive. Furthermore, the employment policies help the unemployed to create their micro-enterprises (78.67%). However, human capital (62.67%), personal behavior (76.00%) and the socio-economic situation of the young workforce (55.33%) explain their negative work perception of work in agriculture. The logistic regression results show that remuneration and incentives, employment opportunities and youth personal behavior affect significantly the likelihood of a labor shortage. Policymakers should focus on improving labor conditions, incentivizing wages, and promoting labor-saving technologies to address agricultural labor shortages and enhance the sector's appeal, particularly for youth.

Keywords: *Agricultural labor market, Labor shortage, Labor segmentation, Human capital, Vegetable crops, Algeria.*

1. Introduction

Over the past 20 years, agricultural employment has declined from 40% to 27% of total world employment. Highly contrasting variations have been observed between low-income countries (59%) and high-income countries (3%). In con-

trast to employment growth in the service sector (40% to 50%) and a slight increase in industry (20% to 23%), unemployment rates fluctuate between 6.1% and 6.9%, with unemployment among young people aged 15 to 24 rising from 13.1% to 17.2% (ILO, 2021). Research on agricultural labor

* National Higher Agronomic School - Kasdi Merbah (ENSA), El Harrach, Algiers, Algeria.

** National Research Institute for Agriculture, Food and the Environment (INRAE), UR ETTIS, Bordeaux, France.

*** Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg, Germany; Department of Agricultural Economics and Rural Development, University of Göttingen, Göttingen, Germany.

Corresponding author: m.chaami@edu.ensa.dz

issues has captured the attention of various scientific disciplines such as sociology, ergonomics, and economics. These fields have introduced diverse research methodologies and analytical approaches, covering topics such as occupational health in agriculture, immigration trends and the dynamics of agricultural and rural labor markets, gender disparities and wage discrimination, working conditions, household strategies for allocating family labor, organizing farm work, and the management of employment within global value chains (Malanski *et al.*, 2019; 2021; 2022).

1.1. Understanding the global phenomenon of agricultural labor shortage

The agricultural labor shortage is attributed to a perceived hysteresis in certain qualifications and the reluctance of agricultural workers who migrate to non-agricultural sectors due to the significant wage gap disparities between the two sectors. This evidence is confirmed in Richards and Patterson's (1998) study of the farm labor market in Washington State. The shortage is evident in the United States across various agricultural productions such as arboriculture, vegetable and livestock farming, and across several states, particularly California (Taylor, 2010; Hertz and Zahnisner, 2013; Richards, 2018; Taylor and Charlton, 2019a). In France, non-agricultural employment in rural regions has grown faster than agricultural employment since the 1980s (Blanc and Perrier-Cornet, 1999). Industrialization has led to a significant rural exodus as high wages attract the poorest rural residents to urban areas. The workers' shortage is evident in cities, but more so in rural areas, particularly for manual and low-paid arduous work (Darpeix, 2013). Even in developing countries such as Togo and Benin, farmers complain about labor shortages during peak periods due to inadequate family support and the scarcity and high cost of manual labor (Batawila and Pleines, 2010). In Ethiopia, labor shortages are associated with transportation delays and the cancellation of coffee production contracts. Local labor shortages forced cocoa producers in Ghana, tea producers in India and Kenya to increase working hours (ILO, 2022).

The problem of agricultural labor shortage

is still relevant in high-income countries with a long tradition of importing foreign labor. In the United States, migrant worker acquisition programs - mainly Mexican - have been in place since 1917 for seasonal (Martin, 2007; Taylor, 2010; Martin, 2014; Charlton and Taylor, 2016; Taylor and Charlton, 2019a). Despite immigration restrictions, Western European countries in particular (France, Spain, Italy, Germany, Great Britain) have continued to import seasonal workers from Eastern Europe (Albania, Poland, Romania, Bulgaria) and North Africa (Morocco, Tunisia) (Morice and Michalon, 2008). Farmers in these countries face challenges in attracting migrant workers due to precarious employment and working conditions, which are denounced by farmworker advocates who urge governments to strictly enforce labor laws. However, these unfavorable conditions, characterized by low wages, lack of social security and informal contracts with labor organizations, are indispensable to maintain the profitability of fruit and vegetable farming activities, which are the main sectors for hiring immigrant workers (Morice and Michalon, 2008).

1.2. Algeria's labor market context: major challenges for agricultural employment

In the Algerian labor market context, the overall labor market situation highlights a decrease in the unemployment rate from 28.9% in 2000 to 11.4% in 2019, marked by a very slight increase over the last decade, but it remains higher among young people in the 16-24 age group, ranging from 54.9 to 26.9% (ONS, 2021a). These changes are the result of demographic mutations, in particular the evolution of the active population, mainly young people, and their activity patterns, with still low female participation, as well as economic development and various employment policies (Musette, 2014). Moreover, a third of Algeria's active population (around 12.3 million workers) was located in rural areas in 2017, with an unemployment rate of 9.4% compared to a rate of 12.9% recorded in urban areas (ONS, 2017). In fact, apart from the high concentration of unemployed people in urban areas, living in rural areas facilitates access to agricultural em-

ployment, often as family workers, but restricts opportunities for informal urban employment (Hammouda and Souag, 2012; Lassassi and Hammouda, 2012a). The rural labor force has no alternative but to engage in several off-farm activities to earn substantial external income, or to settle in small farms due to the limited promotion of rural employment (Bessaoud, 2006). The share of agricultural labor in total employment has been steadily declining, falling from 14.1% to 9.6% over the past 20 years (ONS, 2021a), compared to 51% in 1966 (Bedrani and Cheriet, 2012). The service and trade sectors strongly attract more than 60% of total employees (ONS, 2021a). Although agriculture is the main sector providing employment in rural areas, its share of the total employed population declined from 39.5% to 22.3% between 2001 and 2017. At the same time, trade and services captured more rural workers, increasing from 39% to 46.4 % (ONS, 2001; 2017). This paradoxical evolution can be explained by the improving life quality of the rural residents, made possible by the redistribution of oil rents, which simulates their preference for non-agricultural jobs (Bedrani and Cheriet, 2012). Rural exodus has undoubtedly contributed to the reduction of agricultural workforce, boosted by the expansion of the industrial sector in the early 1970s, which promised advantageous incomes. Agriculture, previously the largest employer with 48% of the workforce in 1970, fell to 40% by 1973. Meanwhile, underemployment disproportionately affected those remaining in rural areas, impacting 31.7% of wage earners (Lassassi and Hammouda, 2012b).

In parallel to long-term unemployment – 63% of the unemployed (ONS, 2019) – there is talk nowadays of a shortage of agricultural labor. Rather, it is a question of a labor force that refuses to work, particularly young people (Bessaoud *et al.*, 2019). When discussing this point, it would be interesting to mention that the NEET rate in Algeria – referring to young people aged 16-24 who are neither employed nor in education or training – reached 26.2% in 2019 (ETF, 2021). This high rate, as in the MENA region (Middle East and North Africa), can be partly explained by youth discouragement, stemming from poor working conditions in the formal sec-

tor and high unemployment due to a mismatch between high education levels and employability in the labor market, as highlighted in the same report. Researchers have observed a number of reasons for the labor shortage, fundamentally due to the arduous living conditions in rural areas: hard agricultural work, low wages, insecure jobs outside the scope of employment legislation, weak professional qualifications and training, and more underemployed rural population with low education levels (Bessaoud, 2006; Omari *et al.*, 2012; Bessaoud *et al.*, 2019).

1.3. Research hypotheses

This paper presents an analysis of the agricultural labor market, as well as the extent of labor shortage and its causes. We formulate the following hypotheses in response to the research question.

Hypothesis 1. Farm labor reveals the characteristics of a secondary segment of the labor market: low real wage levels, less-skilled, precarious, unprotected jobs and poor working conditions.

Since the pioneering work of Doeringer P.B. and Piore M.J. in the 1960s and 1970s on the dual labor market theory (Zajdela, 1990), the labor market is no longer considered as homogeneous as the neoclassical orthodoxy assumes. Dualism explains wage inequalities and working conditions that are not directly related to human capital by identifying two opposing labor markets. The first is the primary market, characterized by stable, skilled, and well-paid jobs with favorable working conditions and strong employee bargaining power. In contrast, the secondary market consists of unstable, low-skilled jobs with poor working conditions, often occupied by young people, women, and immigrants. Mobility between these two markets is notably limited (Perrot, 1992).

Hypothesis 2. Young people's preferences, based on their human capital and their personal and socio-economic characteristics, tend towards alternative employment opportunities. These in-

clude accessible urban jobs in the tertiary sector and government-supported initiatives for establishing their own micro-enterprises.

Although they constitute the basis of the duality of the labor market, the macroeconomic model of Lewis (1954) and the microeconomic model of Harris and Todaro (1970) elucidate the inter-sectoral mobility of workers: from agriculture or rural areas (unprotected sectors) to industry and services (protected sectors), which further explains the wage differentials that encourage these transitions. These classic models do not, though, overlook the urban informal sector (Hammouda and Souag, 2012; Adair and Bellache, 2018).

2. Materials and Methods

2.1. Study area

We have chosen a market-gardening region for our study because of the diversity of labor contracts and market configurations, probably segmented, that can be observed there. The vegetable crops pole of M'zirâa in the Algerian Sahara, east of Biskra (about 480 km from Algiers), is dominated by a greenhouse and field vegetable production, as shown in Figure 1. Added to a small existence of date palm farming representing 0.7% of the total production of dates in Biskra (DSA, 2017). A large part of the population of M'zirâa (65.3%) lives in dispersed

housing, while 34.7% live in the chief town and secondary agglomerations. In 2016, the population was primarily young people aged 15-29 (32%) and children (32.8%), with the 30-59 age groups representing 29% (DPSB, 2017).

In the wilaya (province) of Biskra, 52.5% of total employees work in agriculture, 24.1% in administration, and 11.6% in trade and services. In 2017, official statistics recorded an unemployment rate of 5.18%, lower than the national figure of 11.7% (ONS, 2017). The wilaya has experienced a major boom in market gardening at the national level, characterized by intensive greenhouse production (Bouammar, 2010; Daoudi, 2016; Laouar *et al.*, 2023). It comes in first place, accounting for 52% of national plasticulture production in 2019 (MADR, 2021). The commune of M'zirâa is the largest in the wilaya in terms of plasticulture and open field area (22% and 18%), accounting for 22% and 17% of the wilaya's total production, respectively (DSA, 2017). This commune alone contributes 11.23% of national plasticulture production, with 1,216,996 quintals in 2016. Since 2009, the plasticulture system with canary greenhouses has characterized this region, occupying more than 70% of the total area under canary greenhouses in Biskra. This hyper-intensive system is enjoying a remarkable dynamism, thanks to the young sharecroppers (Naouri *et al.*, 2015), but also to the qualified migrants.

Figure 1 - General characteristics of farms and their production systems in the different localities of M'zirâa (photos taken in 2019): (a) Dominant occupation of agricultural land with a strong activity of plasticulture and field vegetable production, and a low existence of date palm culture; (b) Tomato crop (*Tofane* hybrid variety) in canary greenhouse of one hectare before the first harvest.



(a)



(b)

2.2. Empirical approach

To study supply and demand labor on farms, we developed a cross-analysis between employer and employee trajectories, i.e. interviewing farmers and their family workers as well as salaried employees. This method was used in the case study by Madelrieux *et al.* (2009) on the itineraries of employees on livestock farms in the northern Alps (France). For our empirical analysis, primary data were collected during the 2018 and 2019 crop years through questionnaires with 132 operators and co-operators, and 18 employees present on 125 farms. Only on 12 farms it was possible to interview both the employer and his employee. The operators and co-operators represent 88% of the respondents, including 54 owners, 28 tenants, one associate and 49 sharecroppers, i.e. one respondent per farm, except for seven farms with two respondents. On the other hand, the employees interviewed (12%) are constituted of seven wage earners, nine sharecroppers and two family workers. The sharecropper is the person who essentially takes charge of the work on the farm, and is remunerated by a percentage of the achieved production (Daoudi *et al.*, 2017). He may also be involved in another type of arrangement, such as land tenure (access to land and contributions of the rest of the factors of production) or partnership as (equilibrated association) (Colin, 2003).

Two questionnaires have been developed: the first one with farmers, it covered four parts: 1) individual farmer characteristics; 2) farm labor supply and demand and labor shortages; 3) working conditions, bargaining conditions, and other aspects; and finally, 4) managing farm labor shortage and understanding its causes. The second questionnaire was submitted to seasonal and permanent workers. It was divided into four sections: 1) individual worker characteristics; 2) qualifications and career path inside/outside the agriculture; 3) occupations on the farm and working conditions; and finally, 4) employment ambitions and opinions on labor shortage. We started with exploratory surveys, conducting semi-structured interviews with a dozen experienced large-scale farmers, resource persons,

an inputs supplier, and officials from agricultural institutions and administrations involved in employment sector in the wilaya of Biskra. Farmers were selected via snowball sampling and chance encounters. The Surveys coincided with various farm activities, avoiding peak periods like transplanting to prevent disruption. It should be noted that it was difficult to interview casual workers organized in groups during peak periods, as well as illegal migrants and women workers, given that requires the organization of homogeneous focus groups.

We divided the study region into four large zones, close to secondary agglomerations and distinguished by their vegetable crops potential. Farmers were selected using a stratified random sample and proportional to farm size, drawn using Excel's "Rand" function from lists of farmers available from the department Chamber of Agriculture. We took into account replacements for unavailable individuals who were absent or registered under different names, or who had changed zones of activity or farm size. Two categories of vegetable crops producers were then distinguished in each zone according to their main activity: plasticulture and open field production, each with three classes of vegetable crops producers according to the size of their farms: small (<0.5 ha of greenhouses or <2 ha), medium (0.5-1 ha of greenhouses or 2-5 ha), and large (1+ ha of greenhouses or 5+ ha). With no reference for farm economic size, farmers were classified according to regional standards; for instance, a farm with fewer than six greenhouses is considered small.

The number of farms surveyed is determined using Bernoulli's formula:

$$n = Z^2 \times N / Z^2 + L^2(N - 1)$$

where: n is the sample size to be surveyed; N is the total number of vegetable crops producers, equal to 733 farmers selected from 1,103 farmers of all productions; Z is the deviation corresponding to a 95% confidence level according to the reduced normal distribution, equal to 1.96; L is the width of the range expressing twice the margin of error, equal to 0.16 (margin of error of 8%).

3. Results and Discussion

3.1. General configuration of the farm labor market in M'zirâa

Labor analysis moves away from orthodox analysis, which postulates a general market equilibrium and full employment, by embracing heterodox approaches to explore issues relating to unions and wage bargaining, employment policy intervention, etc. (Cahuc *et al.*, 2014; Vercherand, 2014). Or a more detailed analysis using historical facts from the 19th century and hypotheticals targeting the framework of Juglar and Kondratieff crisis cycles (Vercherand, 2014). Figure 2 outlines the general configuration of the agricultural labor market in M'zirâa¹, wrought by institutions like social conventions of sharecropping, setting it distinct from other markets.

Farm labor demand comes from diverse figures: landowners, tenants, and sub-tenants those who rent entire parcels of land and lease out locations for greenhouse tunnels sites. Sharecropper designed as co-operator, is part of the “one-third production partnership” may lack full range of decisions regarding the technical itinerary and commercialization. Experienced sharecroppers from wilayas such as Batna and Khenchela (≤ 150 km from M'zirâa), or those from Tipaza (510 km from M'zirâa) who have long experience in plasticulture can take the initiative in managing the farm with the owner's agreement. Labor demand depend on several factors such as input and product prices, technological progress and changes in farming practices (Huffman, 2001; 2014).

Farm labor supply is principally sourced from family labor, i.e. members of the farm manager's family and other relatives, and external labor, i.e. employees and sharecroppers classified as “work relationships”, remunerated as associated at one-third of production. Facing difficult local conditions and limited job opportunities, sharecroppers join farms as permanents, given to initial financial constraints, and often arriving with their families. Schematically, two prevalent work contractual arrangements are deciphered in Biskra: salaried

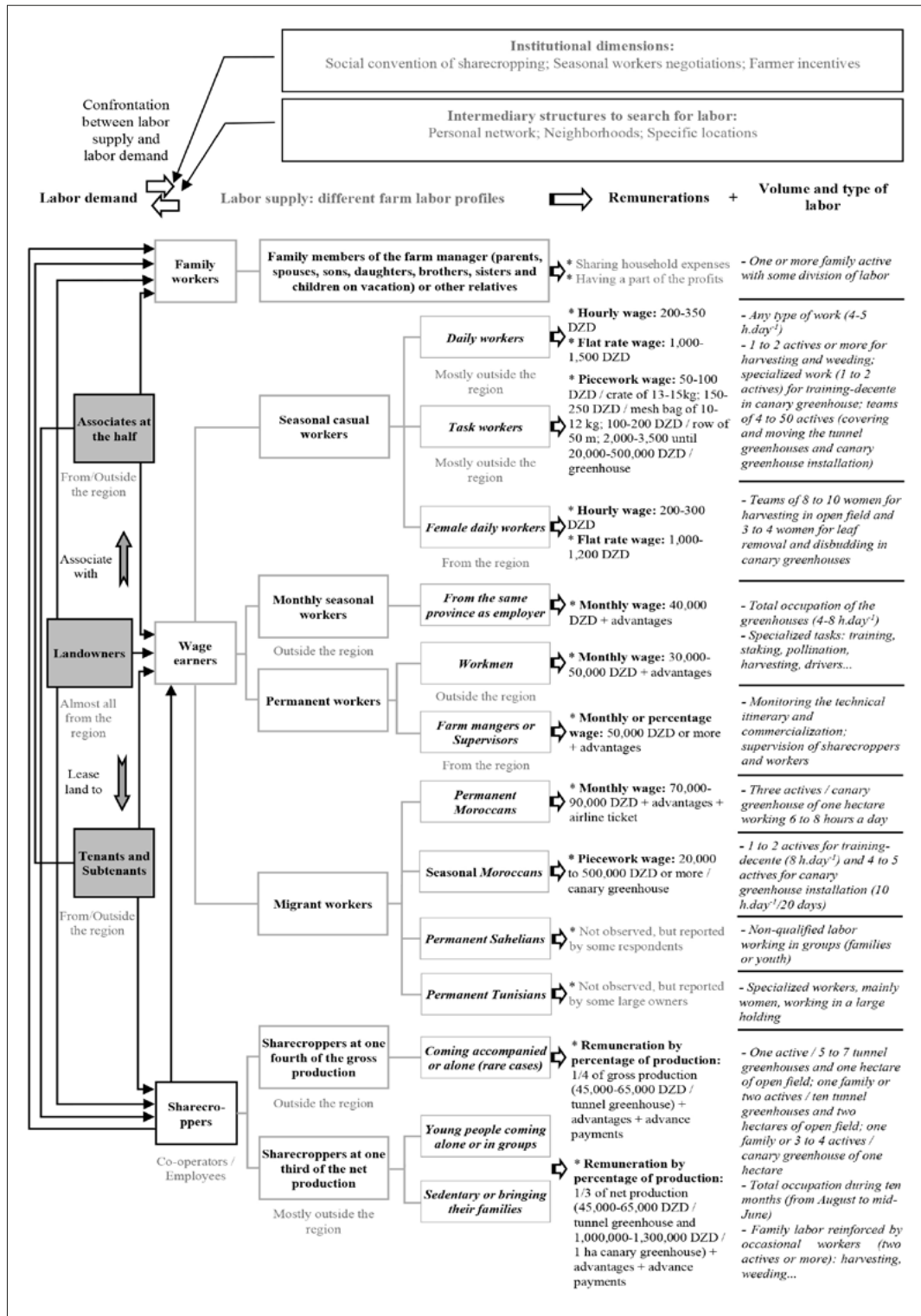
employment for seasonal workers and sharecropping for permanent workers assisting owners, tenants and subtenants switching between market gardening and date palm cultivation (Amichi *et al.*, 2015; Ouendeno *et al.*, 2015).

Permanent and seasonal skilled Moroccan migrants were present on 18% of surveyed farms, but only 5% actively recruited them in 2018-2019. Since 2009, this migration has impacted the availability of skilled labor and brought a new know-how in canary greenhouses production, imported from the Souss region of Agadir (Morocco) (Naouri *et al.*, 2015), itself of Spanish origin. The specific tasks that encourage the employment of Moroccan workers include installing canary greenhouses, tomato trellising techniques and fractioning fertilizer units. Their shrinking numbers stems from absence of work permits while they used tourist visas and the search for opportunities closer to home.

Some owners reported the presence of Sahelians from Mali and Niger, refugees coming from conflict zones, and Tunisians sought for specialized tasks in large holdings producing high-value crops such as cherry tomatoes under multi-span greenhouses. The working conditions of Sahelian migrants are under-researched due to limited access to these workers, as with other migrant groups. They often work discreetly in groups for several days or months, performing unskilled tasks like surveillance, weeding and harvesting. In constant labor scarcity, large owners can train them for more skilled jobs. Thus, labor migration, fueled by economic prospects, bears reminiscent economic and social implications for both sending and receiving regions, and is often influenced by wage differentials, skills requirements and immigration policies (Taylor, 2010; Taylor and Charlton, 2019b). The categories of full-time or part-time wage earners, local or foreign, under various contracts, are underscored in contemporary literature concerning their responsibilities and skills, which are *crescendo* replacing family labor in many countries around the world (Bignebat *et al.*, 2019; Dedieu, 2019).

¹ The applied wage range is 1 EUR = 1.12 USD = 133.67 DZD (Algerian Dinar) at the average official exchange rate and 200 DZD on average on the parallel market in 2019.

Figure 2 - General configuration of farm labor market in M'zirâa.



Female labor demand is almost nonexistent in tunnel greenhouses due to the hard atmosphere, while in canary greenhouses it is mainly for harvesting legumes and sporadically for leaf removal and disbudding. To address daily laborers shortages, some farmers consider hiring only women for lighter tasks. Though their productivity may be lower for urgent harvesting, they perform tasks with patience and precision. Women from sharecroppers' families may also undertake harder work, like spreading and burying manure, hoeing and weeding. Women's rural employment in Algeria is often misrepresented, as it requires specific tools to measure seasonal and part-time work (Musette, 2014).

Hourly wages for casual workers differ between men and women particularly where farms are far-flung or where the work is difficult. Hourly/daily wages remain benchmarks, offering a fixed salary when task duration is unknown in the absence of agricultural minimum wage laws. Workers prefer piece-wages, as they generate flash income based on physical quantities achieved, and so do employers, as they do not have to supervise the workers. The dilemma is that the work is done quickly, but may damage the plants. Seasonal workers native from the same province as their employers (Tipaza) are recommended to reinforce farm's activities for 2 to 3 months and are rewarded by a fixed daily wage, even on off days. Permanent Moroccans receive monthly salaries in euros at the parallel market exchange rate. Family members generally work together, except for a few specific tasks assigned to one of them, such as commercialization, fertigation and rootball plants preparation. Unpaid family work can be reimbursed by a share of profits in the case of operators living in compound households.

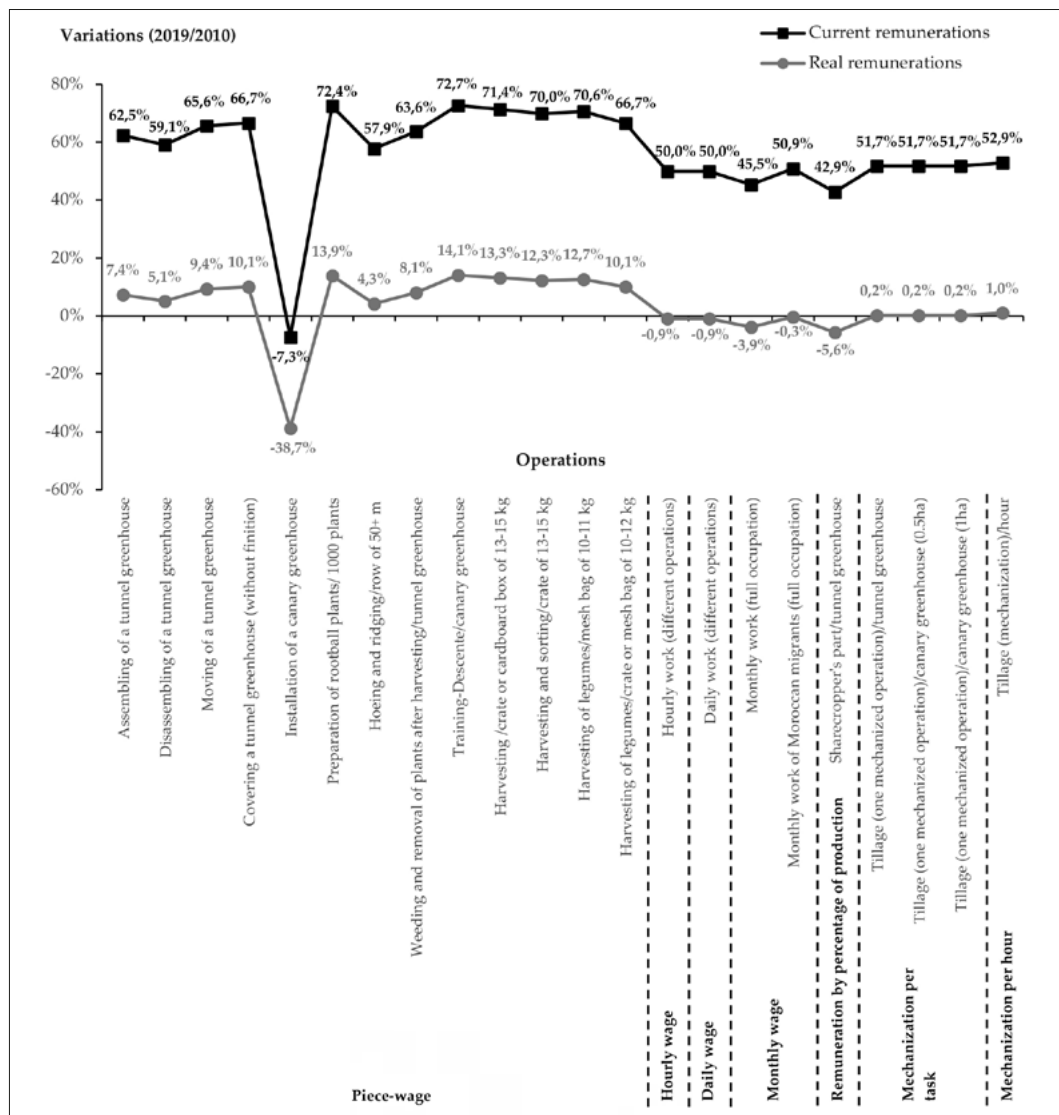
The sharecroppers agree with the operators for a third of the net production, and very rarely for a quarter of the gross production. The sharecropping convention, in sense of a non-negotiable contract that determines the local contractual arena (Colin, 2002) or in sense of social and wage negotiations (Cahuc *et al.*, 2014), is a locally entrenched tribal institution, whereas the formation of a committee named "*Djemâa*", made up of notables and farmers from the region, acting as an enforcement mechanism of

the agreement. From August to June, the sharecropper handles: nursery work, greenhouse covering, manure spreading, transplanting/seeding, irrigation, crop maintenance tasks and harvesting. For more responsibilities, he contributes a third of the costs of: tillage, manure, seeds or rootball plants, fertilizers, phytosanitary products, agricultural twines, mulch, drip lines and commercialization. The sharecropper assumes no fixed costs or climatic or production risks, but is in charge of paying casual workers. This whole process of arranging sharecropping terms and enforcement mechanisms mirrors practices in the west of Biskra, with differences in the proportions of costs and benefits, the linked contracts and the range of decisions (Amichi *et al.*, 2015; Ouendeno *et al.*, 2015; Ouendeno, 2022). The wage-earning and sharecropping contracts are exclusively verbal, and trust and reputation remain the capital values that manages these arrangements. Similar to other transactions between partners or with input suppliers (Daoudi, 2016; Laouar *et al.*, 2023). In 2014, collective negotiations took place between sharecroppers, employees, local landowners and the *Djemâa* to uplift labor conditions, boost wages and amend the sharecropping agreement. Exemptions in labor contract pursued to streamline processes and curtail transaction costs, i.e. the costs of negotiation, control and supervision, as happens in large oil palm plantations in Indonesia where the paternalistic control dominates (Barral, 2014). These adjustments reflect the labor market segmentation, where workers are treated differently as per their productivity, bargaining power, and pursuit of improved status on a primary market: skilled daily workers aspire to be sharecroppers or permanents in large holdings, in analogy with the antagonisms between insiders and outsiders (Perrot, 1992; Cahuc *et al.*, 2014).

3.2. Wages and remunerations: trends and incidences on the availability of labor force

The study of wage trends helps to assess labor costs and the increased labor demand, and therefore the possibility of shortages, or the response to collective bargaining or employment policies aimed at increasing workers' purchasing pow-

Figure 3 - Evolution of average current and real wages for different manual and mechanized agricultural works between 2010 and 2019 (2010 = 100).



er (Cahuc *et al.*, 2014). Figure 3 examines the evolution of wages for different farming tasks (2010-2019), after calculating real wages using the consumer price indices in Algeria provided by the International Monetary Fund (2022), which have a base 100 for the year 2010 and a value of 151.36 for the year 2019.

M'zirâa's average current remunerations – excluding salary costs – saw significant growth between, raised from 42.9% for sharecropper's part/tunnel greenhouse to 72.7% for training-de-

cente. Only installing canary greenhouses, at first done by seasonal skilled Moroccan migrants, witnessed a sharp decline (-38.7%). This drop is attributed to a shift to trained locals and increased competition among service providers. Real wages tell a different story, particularly for sharecroppers and permanents, which declined by -5.6% and -3.9% respectively. Moroccan migrants, initially the highest earners given their mastery of the entire technical itinerary, also faced low real wage growth of -0.3%.

Real piece-wages rose sharply in activities requiring teams of workers, like field harvesting (10.1% to 12.7% increase) and greenhouse preparation (5.1% to 10.1%). The same for one-off tasks like weeding before mulching and greenhouse cleaning and hoeing and ridging (4.3% to 8.1% increase). Additionally, moving the greenhouses replaced the activity of assembling/disassembling which is a costly operation, especially for tenants who change their farms location. Legume harvesting wages favored for easily picked crops always in bags like broad beans and peas compared with beans. Harvesting in greenhouses, not requiring large teams, registered a 13.3% real wage increase, compared to simultaneous sorting (12.3%) generally handled by the employer. Rootball plants preparation and training-decente remained the most profitable tasks, with an increase in real terms of 13.9% and 14.1% respectively, because of their time-sensitive nature and rigorous monitoring. Before the demand in canary tomato greenhouses increased, training and knowledge exchange were primarily mutual aid acts among former Moroccan workers. Mechanized tasks, which only include tillage operations, i.e. ploughing, disking, digging furrows and an optional milling, tend to increase remuneration slightly more than manual operations (except piecework), averaging 1,000 DZD/tunnel and 1,200 DZD/hour in open field. Both hourly and per-task real rates show positive trends. Mechanization per hour has increased, since the mechanization service provider can work on more than one greenhouse at the same time. Most operations remain manual, minimizing mechanization's impact on overall wages.

By offsetting the striking effect of inflation, the increases of different remunerations may indicate the existence of a local farm labor shortage. As echoed in U.S. farms, evinced by wage adjustments for hired workers, mostly immigrants (Martin, 2007; Hertz and Zahniser, 2013). Hourly wages in California fluctuated seasonally from 9 to 14 USD between 2002 and 2014, despite the availability of advanced mechanization and migrant labor (Taylor and Charlton, 2019a). Some equilibrium models predicted higher wages by 22% if even half of illegal farm workers

leave (Richards, 2018). Some greenhouse growers may offer sharecropping contracts to qualified permanent migrants with relief from some charges, or even propose sharecropping at $\frac{1}{3}$ of the gross of production, owing to the high transaction costs of remunerating them. Future remuneration in both sharecropping and wage-earning contracts may evolve in line with working conditions and labor shortages. Similarly for sharecropping at $\frac{1}{4}$ of the gross production in the western region of Biskra from which some farmers will propose sharecropping at $\frac{1}{2}$ to remedy the lack of arms (Ouendeno, 2022).

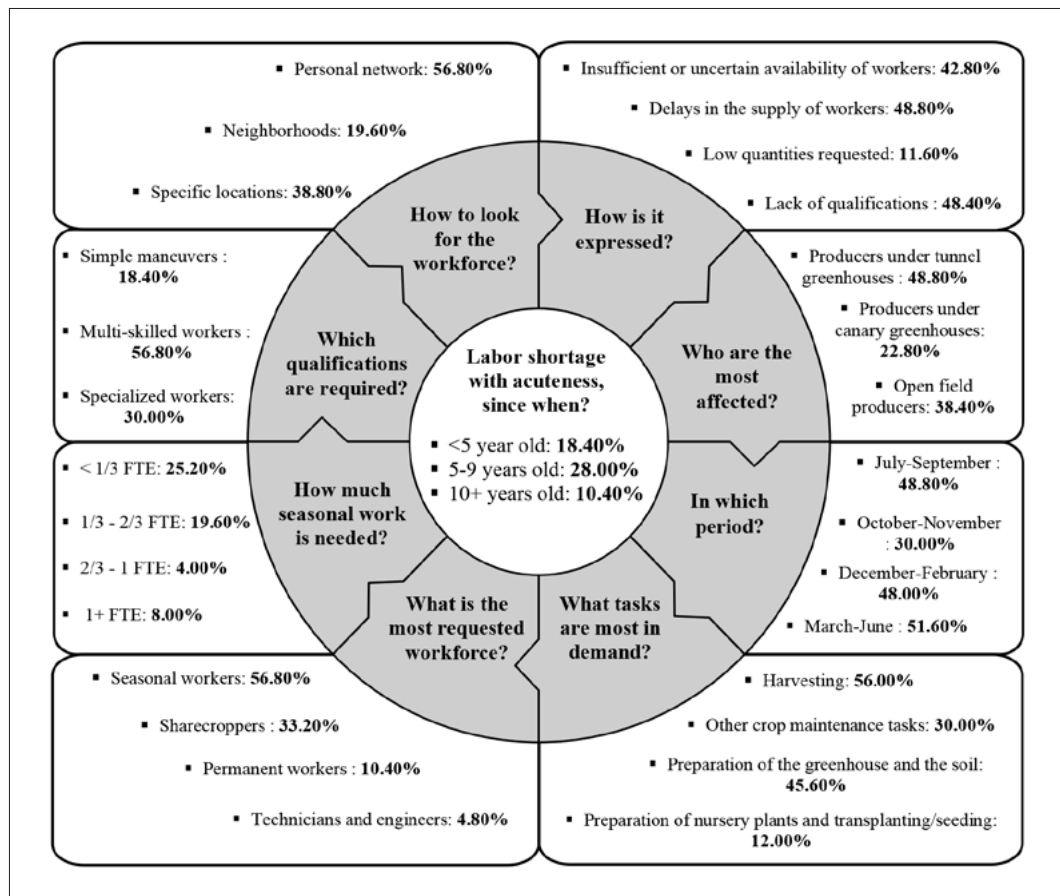
3.3. Labor shortages in vegetable crops farms: where does the situation stand?

The scarcity of workers has been a source of concern for 56.80% of surveyed farms. Its extent differs from year to year and is illustrated in Figure 4. Estimating labor shortage poses challenges without quantitative data on labor demands and available workforce. Arrival delays of workers after lengthy search process or pending appointments, unsatisfactory qualifications and insufficient or uncertain crews' availability during intensive operations are the major facets of farm labor shortage.

Labor shortage intensified since 2010 following the development of modern greenhouse techniques, and peaked between 2012 and 2014 when many sharecroppers achieved good campaigns, leading some of them to subsequently become tenants. The situation worsened the last five years after the collective sharecropping negotiations and the rises in inputs prices, and became permanently dire for more than ten years in the farms of the large and old producers. The farms suffering with labor shortage during the 2018 and 2019 campaigns are experiencing a serious consequences. Activities like open field vegetable crops were abandoned, with the possibility of returning to the activity. Vital tasks such hoeing, ridging and the last 2-3 tomato harvests suffered delays or even stoppages.

Of 61 afflicted farms, the labor shortage appears from a plasticulture area equivalent to ten greenhouses or a canary greenhouse of 0.5 ha, cultivated mainly with tomatoes (31%), chili and

Figure 4 - The extent of the labor shortage on the 125 farms surveyed from the expression of the labor shortage by affected farmers to the process of finding workers.



peppers (39.6%), melons (10.61%), eggplants (6.72%) and zucchinis and beans (4.42%), rotating with melon cultivation (7%), whether accompanied by open field gardening or not. From an area of 3.5 ha of open field crops alone, the farmer is exposed to labor shortage, especially for pea and green bean harvesting by daily laborers, or for onion planting and harvesting by teams of more than ten men. Small greenhouse growers with less than nine greenhouses, who cultivate open field crops on 0.5 to 4 ha, also suffered from labor shortage due to their lack of seniority in the region or the absence of family workers.

All farms in short supply need seasonal workers instead of permanent workers, who account for 10.40% of total demand. The seasonal nature of farm work imposes internal and external labor flexibility to meet demand variations (Mundler

and Laurent, 2003). However, sharecropping is an important way to compensate for family labor deficiency and is preferred to hiring permanent labor. The *ex-ante* demand for sharecroppers is made in one-third of farms. The demand for technical managers remains weak (4.80%), even among large-scale producers. In this respect, technicians and engineers from agro-supply firms and local input suppliers play a key role in the dissemination of technical innovations and agricultural advice in the wilaya of Biskra. This approach reinforces private extension mechanisms and builds customer loyalty (Laouar *et al.*, 2023).

Qualification is not linked to professional training or higher education, but it is translated to years of experience (1+ year). Multi-skilling is imperative in all farms affected by labor shortage, because it showcases workers' ability

to acquire new skills and his availability in the event of breakdowns or missing/absent posts. Compared to a simple worker, a multi-skilled worker has a degree of autonomy to work unsupervised and can participate in future farm decisions (Vincq and Granié, 2014). In 30% of farms, specialized skills are indispensable from highly skilled tasks like tomato maintenance to meticulous work without paying too much attention to the qualifications, as in harvesting legumes by female laborers.

Quantifying working time helps to clarify the organization of farm work and its efficiency and flexibility, and to predict the availability of labor on/off the farm (Dedieu, 2019). A quarter of the farms are looking to hire less than 0.33 FTE² and 8% for more than 1 FTE, of which producers cultivate open fields between 3.5 and 6 ha or mainly under canary greenhouses. We calculated 65,977 needed work hours on farms in labor shortage. Harvesting tasks consume 61% of the work volume from winter until early summer, followed by greenhouse and soil preparation operations in summer (25%) and crop maintenance in autumn until spring (11%). Nursery plants begin in late July and August, and transplanting, which can extend to the end of September for some late season varieties, make up 3%.

In the absence of formal recruitment mechanisms, farmers tap first and foremost personal networks through contacts with previous workers, team leaders, input suppliers, etc. Employers harness their social capital to uphold trust and reputation of workers, as well as workers who inquire about good employers fearing moral hazards. Secondly, farmers resort to the spot market to find seasonal labor in specific locations like cafeterias, wholesale markets, etc. Thirdly, neighborhoods constitute proximity networks for legume harvesting and mutual assistance during transplanting. Intermediaries can mitigate high labor transaction costs when information is asymmetric. These intermediaries can be: 1) specialized individuals usually linked to workers by family, territory or ethnicity, sim-

ilar to Senegalese agropastoralists (Wane *et al.*, 2018); 2) enterprises that place workers under numerous contracts, as in France (Darpeix, 2013); or 3) Farm Labor Contractors (FLC) to hire and move teams of seasonal workers in the United States (Martin, 2014).

3.4. Determinants of farm labor shortage and low youth participation in agricultural activities

We examine the causes of labor shortage in M'zirâa's vegetable crops farms using a binary logistic regression model. We analyze the impact of proposed hypotheses on the likelihood of labor shortage. Studies on the segmentation and functioning of the Algerian labor market employed diverse econometric analyses as multinomial/binary logit/probit models, etc., corrected by statistical methods and tests (Heckman, Fisher test...) to explain occupational choices in the different employment segments (Hammouda and Souag, 2012; Adair and Bellache, 2018; Merouani *et al.*, 2021). As also found in studies demonstrating on-farm versus non-farm work choices (Tocco *et al.*, 2012). The binary logistic model in Table 1 tests six nominal predictor variables based on respondents' declarations affected or not by labor shortage, in addition to a cause considered obvious. We added a nominal control variable related to the expression of cryptogamic disease and pest risks in all types of farms.

The likelihood ratio test for the dependent variable, annexed by the degrees of freedom, Wald chi2 and p-value statistics, compares the fit of the full model to a model without the predictor variables, and evaluates the significance of the independent variables in explaining the variation in the outcome, as shown in Table 2.

The model demonstrates a good predictive capacity, with a reliability test confirming 72.67% of correct predictions. The results of the logistic regression model show that the model as a whole is significant, indicating that the predictors collectively have a significant effect on the likeli-

² Full-time equivalent, determined at 1800 h/year as the legal working time on farms defined in the 1996 Labor Code.

Table 1 - Logit model of main causes of labor shortage and low participation in farm labor market.

	<i>Labor shortage</i>	<i>Coef.</i>	<i>Std. Err.</i>	<i>z</i>	<i>P> z </i>	<i>[95% Conf. Interval]</i>	
Hypothesis 1	Remunerations-incentives	-1.602	0.495	-3.23	0.001	-2.573	-0.631
	Working-living conditions	-0.547	0.491	-1.11	0.265	-1.508	0.415
Hypothesis 2	Job opportunities	1.146	0.560	2.05	0.041	0.049	2.242
	Personal behavior	1.208	0.485	2.49	0.013	0.257	2.159
	Human capital	0.013	0.418	0.03	0.976	-0.807	0.833
	Socioeconomic situation	0.321	0.420	0.76	0.445	-0.502	1.144
Evident cause	Increase in area-farm size	0.591	0.782	0.76	0.450	-0.941	2.123
_cons		-1.249	0.843	-1.48	0.139	-2.903	0.404
Disease-pest risks		1	(offset)				

Table 2 - Logistic regression parameters of full and reduced model.

Full model						
Wald chi2 (7)	Prob > chi2	Log likelihood	Likelihood-ratio test			
			LR chi2 (7)		Prob > chi2	
24.88	0.0008	-80.8106	42.47		0.0000	
Reduced model						
			Number of obs		=	150
			LR chi2(0)		=	-0.00
			Prob > chi2		=	.
			Pseudo R2		=	-0.000
			Log likelihood		=	-102.044
Labor shortage	Coef.	Std. Err.	z	P> z	[95% Conf.	Interval]
cons	0.323	0.165	1.95	0.051	-0.001	0.647

hood of labor shortage. The Wald chi2 value is 24.88 indicates a statistical significance of the model at 1%.

3.4.1. *The obvious cause of the labor shortage*

It is evident to 90.67% of respondents that as farm area and size increase, the demand for labor rises, making the labor shortage more severe. Between 2007 and 2016, vegetable crops areas in M'zirâa expanded from 126 to 1,249 ha for plasticulture and from 1,424 to 2,600 ha for open field (DSA, 2017). Their average annual growth rate was 10.2% (DSA, 2017), surpassed the wilaya and national averages, with rates of 8% and 4.2%, respectively (MADR, 2019). The extension of the areas of irrigated farms in Biskra has been spurred by the ag-

ricultural policies implemented (Bouammar, 2010), but also by the burgeoning of a tenancy land market that is inclusive of both native and non-native farmers (Daoudi *et al.*, 2017). As for the variable "Increase in the area and size of the farm" in the logistic regression, its coefficient (0.590) is not statistically significant (p-value = 0.450), yielding its limited impact on labor shortage probability. The low coefficient may reflect the fact that this evident cause may have a greater impact in other contexts (newly introduced crops and techniques, large farm models, etc.). Interestingly, in developed countries showing positive agricultural economic growth due to factors productivity growth driven by technical progress, farm size expansion is a fact, accompanied by

a decline in the share of agricultural employment and seasonal labor shortages, largely migrants (Christiaensen *et al.*, 2021).

3.4.2. *Causes of the first hypothesis*

Dual agricultural model in oil palm plantations in Indonesia leads to the segmentation of the local labor market between temporary and permanent workers. The latter benefit from superior advantages and remuneration, including social protection, access to credit, housing and a degree of autonomy in work organization. This segmentation fades due to a labor shortage, forcing employers to accept the conditions of seasonal workers, including their participation in other informal activities, which is the same thing sought by permanents in the absence of an adequate retirement system (Barral, 2017).

In comparison to our case, 70.67% of respondents perceived actual remuneration and incentives as low, with 62.67% attributing low agricultural wages to declining purchasing power and the infrequent use of efficiency incentives to encourage youth in particularly difficult conditions and time-sensitive tasks. Real wage increases have been positive only for piece-rate wages (section 3.2). In 2019, the gross monthly salary of a permanent employee in M'zirâa, without taking into account benefits and advance payments, averaged 40,000 DZD (27,500 DZD in 2010) for all qualifications, below the national average net salary of 41,800 DZD (26,893 DZD in 2010) in the public and private non-agricultural sectors, excluding administration (ONS, 2021b). All received remunerations are never declared to the social security or employment authorities. This is because employers do not declare their workers, who are themselves unaffiliated. Workers also would rather benefit from direct contributions than have them deducted from their wages to pay into an uncertain insurance. The reasons expressed are consistent with those cited by workers excluded from social security or who chose voluntary the informal employment in the Maghreb countries, determined by individuals' risk aversion and temporal preferences (Merouani *et al.*, 2021). Interestingly, a few part of respondent believed in wage discrimination against Sahelian migrants, who are unaware of the terms of the social con-

vention and the wages offered. Skilled migrants are the best paid, close to the national "executives" who receive 81,000 DZD net, without a high level of education, but some workers hold vocational training diplomas in agriculture. Along with other benefits (housing, food, etc.), they effectively occupy a niche in the primary segment of M'zirâa's local labor market.

The poor living and working conditions are relatively high in the study area, as 76.67% of the respondents affirmed. Laborious work is not the least reason for refusing to work in agriculture, that is tiring and requires considerable physical effort in relation to the workload and the acceleration in the rhythm of some tasks, which sometimes complicates the organization of work on the farm for those who do not have enough workers in quickly transplanting, harvesting green beans to avoid hardening the fruit after ripening, carrying out several crop maintenance tasks at the same time, etc. The agricultural profession is considered risky given the recurrence of accidents at work, the lack of hygiene and health protection measures (especially in tomato and eggplant greenhouses), and numerous climatic (heat waves, frost) and natural (scorpion and snake attacks) hazards. For 62.67% of the respondents, the precariousness and seasonality of the work are not conducive to attracting more workers. The examination of working conditions on farms is a pivotal social factor in attracting and retaining labor. It is the focal point of numerous of scientific publications, particularly in ergonomics and agricultural medicine, which delve into the study of health problems in the agricultural workplace, such as musculoskeletal disorders, workload, occupational accidents, mental health, stress, job satisfaction, and pesticide exposure, etc. (Malanski *et al.*, 2019; 2021; 2022).

Working conditions in greenhouses could depend on other factors that significantly influence safety knowledge and practices, notably age, gender, education, health and safety training, work experience, tasks implemented and use of personal protective equipment, as relevant for many vulnerable groups of workers handling hazardous pesticides in extreme weather in the Ethiopian floriculture sector (Geleta *et*

al., 2021). In our study, 39% of the respondents reported that agricultural work is carried out with inadequate hygiene and safety protocols for phytosanitary applications that could make respiratory or allergy-related issues. Additionally, 62% believe they work in harsh conditions and environments fraught. Of these, 8% have experienced direct encounters with scorpions or snakes. During our surveys, the average maximum temperatures recorded between May and September ranged from 39.51 to 42.91°C, with a peak of 48.80°C in July 2019 (NASA, 2023). Hot periods coincide with critical tasks like harvesting, transplanting, etc. restricting greenhouse access after 10 AM.

An in-depth study is recommended to understand female day laborers' market, focusing on their social profiles, negotiations with team leaders, and working conditions. Quantifying their farm contributions and estimating their domestic workload could use methods like the "work balance" approach applied in Morocco's oasis systems (Sraïri and Naqach, 2022). Female agricultural workers in the Global North face strenuous physical and mental stress due to the dual farm and family responsibilities and limited health-care access. Exposure to chemicals and challenging climates also puts their reproductive and overall health at risk (Wheeler and Nye, 2024). Women's contributions on Greek family dairy and small ruminant farms have been crucial for economic resilience. Their extensive farm work reduces the need for hired labor and boosts productivity, allowing husbands to pursue off-farm income (Ragkos *et al.*, 2018). These findings underline the need to recognize and address women's needs in agricultural policies to promote equity, well-being, and job satisfaction.

On the basis of official data from various administrations up to 2016 (DPSB, 2017), we can put into perspective some of the reasons of poor living conditions cited by 44.67% of respondents. M'zirâa is the last commune in terms of school enrolment for children under 15 years (73.50%) and the second last for high school students aged 15-19 (20.7%). No secondary school was built before 2016. The children of sharecroppers are vulnerable to abandoning school and being hired at an early age owing to the long distance or the

absence of schools. Household connections to the potable water and sanitation networks are 95% and 93%, respectively, mainly in the peri-urban areas. There are no sports or youth facilities in the municipality. However, the level of progress of various vital structures and facilities in the commune improved after 2017. Farmers offer lodgings to their sharecroppers and permanent workers, and even to tenants, but these appear to be in modest or moderately acceptable condition.

In our logistic model, any decrease in remunerations and incentives, or working-living conditions, increases the probability of labor shortage. Wages are good predictors with a coefficient of -1.602 and p-value of 0.001, more so than the coefficient of the conditions (-0.546) with a p-value of 0.265, which means there is no strong evidence to conclude that working-living conditions have a significant effect on the likelihood of labor shortage (-80.810). Separating the working conditions variables from living conditions using longitudinal analysis methods could provide more solid evidence for the explanatory variable in question. For the participants surveyed, the working conditions are surmountable, since they all suffer the same difficulties, and it will be more difficult for outsiders to the sector, who make an occupational arbitrage based principally on remuneration; a problem that requires ergonomic solutions. Working conditions are also considered acceptable/livable in terms of demands for free time and reduced working hours for both farmers and workers (Dedieu, 2019). In 2019, 34.3% of the unemployed in Algeria declared that they accept arduous or unhealthy jobs, 54.3% accept jobs outside their wilayas and 81.6% of the unemployed are willing to work in low-paid jobs (ONS, 2019).

3.4.3. *Causes of the second hypothesis*

For our logit model, the coefficient of "employment opportunities" is positive (1.145) and statistically significant (p-value = 0.041), indicating that an increase in opportunities to work in other non-agricultural sectors, as well as opportunities to create micro-enterprises and own jobs, are associated with an increase in the probability of labor shortage. This result accounted for 78.67% of responses. If we consider that

agricultural wages in M'zirâa are net, deducting only the social security contribution without any other taxes or allowances, and compare them with wages in other economic sectors in 2019 (ONS, 2021b), agricultural workers are underpaid in relation to workers in other sectors, since the average net wage (36,400 DZD/month) is 80% of the average net wage in trade, 34% and 85% in extractive industries (hydrocarbons and mining) and manufacturing, 59% in financial activities and 78% in transport and communications, but 1.14 times higher than in construction, 1.04 times in hotels and restaurants and 1.05 times in real estate. Furthermore, agriculture is becoming increasingly less profitable and less attractive, particularly for new entrants with less than five years of experience in the region. In 2019, faced with a low share of agricultural employment, only 4.1% of the unemployed who have previously worked answered that their last job was in agriculture, but 65% of them left the service and administrative sectors (ONS, 2019).

The other cause of the labor shortage, according to 65.33% of the respondents, is the recourse of young people to government subsidies for the creation of their own jobs, especially credits for the creation of micro-enterprises through the National Youth Employment Support Agency "ANSEJ" (now known as ANADE). Agriculture has become the leading sector attracting more projects financed by ANSEJ than any other sector in the wilaya of Biskra since 2011, peaking in 2014 (72% of projects) (ANSEJ, 2018); period of a critical labor shortage in the region. Here is an example of how young people are attracted to these projects. In a successful scenario, a sharecropper working in six chili or bell pepper greenhouses can generate a gross margin of 360,000 DZD/10 months. After paying his debts, he is left with a net income of 210,000 DZD, equivalent to what a daily laborer could earn in a year. This income allows him to buy a greenhouse (used metal frame + new plastic film). Therefore, *ceteris paribus*, he can invest in six full greenhouses after six years of work, saving, in the best cases, a rental lease for one year that is 1/8 to 1/10 of the acquisition value of the greenhouses. The ANSEJ in Biskra can finance six new greenhouses in the first year at a value of

1,500,000 DZD and offer additional support. A sharecropper or a simple worker will shorten the number of years he spends paying off his debts, without having to follow the professional ladder to create his own job.

The coefficient for "personal behavior" is positive (1.208) and statistically significant (p -value = 0.013), which means that certain personal characteristics are associated with an increased probability of youth labor shortage; it is considered inevitable cause by 76% of respondents. The demotivation of young people given the examples of the failure of new farmers, the refusal to work the land for subjective reasons, the attraction to easy, urban jobs even if they are less well paid and the fact that agricultural work is seen as temporary and financially uncertain and poorly esteemed, are factors contribute largely to this outcome. The attitudes towards the low social perception of agricultural are also influenced by the low recognition and undervaluation of agricultural work by some employers, and the bad employment relationships conducive to labor conflicts. These issues are a priority for authors who are interested in improving of workers' personal development in terms of skills and social relations, and who propose evaluation grids for job satisfaction on the farm (Dedieu, 2019). Finally, a quarter of respondents claimed that young people demand more than employers' capabilities and the advantages offered in the social agreement, such as food, transport to home, payment worth half the harvest in difficult conditions at the end of the season, remuneration of sharecroppers at one-third of the gross production, etc. It symbolizes implicit collective negotiations, where syndicate representation and government intervention are absent (Cahuc *et al.*, 2014), or where bilateral negotiations dominate over profit-sharing resulting from employee dissatisfaction (Perrot, 1992).

Job fulfillment often goes beyond improving working conditions, as demonstrated by dairy farmers in the Puy-de-Dôme department (France), who adopt agroecological practices not only to reduce chemical exposure and enhance environmental and human health, but also to achieve economic and decision-making autonomy, optimize work organization, produce

high-quality goods and ensure animal welfare, ultimately to foster a positive professional image (Duval *et al.*, 2021). Our study lacks a detailed analysis of wage earners' feeling and job satisfaction, but insights from Sabillón *et al.* (2022) offer useful perspectives. This research examines how working conditions affect European farmers' well-being and job satisfaction, emphasizing factors such as working hours, age, financial status, and community engagement. Four key dimensions of job satisfaction in farming were identified: daily tasks, work-life balance, professional identity, and decision-making autonomy, all of which influence quality of life.

The coefficient of "human capital" is very low (0.0128) and not statistically significant (p -value = 0.976). This indicates that human capital factors (such as age, education, social capital, qualifications outside agriculture...) do not have a significant impact on the probability of labor shortage in our model. The impact of education is low relative to skill specialization on agricultural labor market participation, typically in the context of technical change (Huffman, 2001). In reduced form models, education has a minimal improvement effect on wages in the United States, with each additional year of education contributing to an increase in average hourly wages of less than 1% (Richards, 2018). Compared to what was reported by 62.67% of respondents, the shortage of young laborers in agriculture is mainly due to the fact that farm management skills are less prevalent amid people from non-agricultural environment, and the more educated individuals are less willing to work in agriculture. Late entry into farming diminishes the desirability of agricultural work for youth. It is noteworthy that 88% of our surveyed individuals began working in agriculture as family workers or wage earners before the age of 19, with over 2/3 started before the age of 15. However, people with qualifications or experience outside agriculture have little chance of working in agriculture.

The coefficient of "socio-economic status" (0.320) is low and statistically insignificant (p -value = 0.445), suggesting that socio-economic characteristics of the youth labor force, do not have a significant effect on the probability of labor shortages rather than what 55.33%

of respondents indicated. Married individuals, particularly heads of households or eldest sons within compound households, are more inclined to engage in agricultural activities. The sharecropper with his family, whose children attend school, is preferred because he will stay for the whole season. Nevertheless, the lack of stability due to the movement of workers, especially with their families, reduces the chances of participation in agricultural work. It should be remembered that 54% of our respondents came accompanied, outside the municipality. Declining interest of youth in agriculture for reasons of other financial resources (pension from parents, rent of premises, etc.) and challenges of access to land seem to be unconvincing reasons. Econometric models analyzing wage disparities between different segments in the Algerian labor market and the employment prospects therein divulged the following findings: women, young people under 30, single people and the less educated (below secondary level) participate much more in urban informal labor market as self-employed, undeclared workers, home-based active women or family workers, and to a lesser extent in agricultural employment (Hammouda and Souag, 2012; Lassassi and Hammouda, 2012a; Adair and Bellache, 2018). Including variables related to socio-economic characteristics into the human capital variable could improve our logistic model, as realized in these studies.

4. Conclusion and Perspectives

The results of the logistic regression amalgamating insights from 150 employers and employees suggest that: the level of agricultural remunerations and incentives, employment opportunities in other sectors and government support for the creation of self-employment, and the personal behavior of the youth labor force are the central factors influencing the probability of labor shortage. The disparity in wages and incentives delineate a segmentation that thwarts workers from achieving a good professional status, who in turn change their qualifications or move to other sectors. Factors such as working and living conditions, human capital and the socio-economic status of young people, as well as the increase in the area and size

of farms in the region, which is considered an evident cause, do not appear to have significant effects. If young people are demotivated and refuse to work in agriculture, preferring easy urban jobs, it is because they also consider agricultural work to be precarious, arduous and with no social security cover. These factors explain why more than three-quarters of respondents believe that young people find agricultural work repellent and insufficiently valued.

As with the development of labor-saving technologies, work in the greenhouses or open fields at M'zirâa is highly hand-dependent, given the numerous maintenance activities that do not allow easy access to large equipment. Ergonomic improvements to a number of tools (e.g. seeding/transplanting equipment, rolling elevators to facilitate trellising and harvesting at height) could be a springboard for other innovations, helping to respond efficiently to the uncertain labor availability. Today, the robotization of agricultural tasks is a new agricultural revolution. These intelligent technologies still pose the challenge of combining three fundamental functions as long as human pickers can do it naturally: 1) the discernment (detection capacity); 2) the speed of task execution; and 3) the dexterity (avoiding damage to delicate fruit) (Taylor and Charlton, 2019c). Policy implications can also play a part in remedying labor shortage or underemployment through modification of labor regulations and social protection tailored to the agricultural sector; enhancement of more incentivized agricultural remuneration as offered in employment support programs; and encouragement of employer groups or private enterprises for intermediation and provision of labor services, handling or new mechanization technologies. These structures can provide a better framework for the formation of worker's human capital, which responds to good work organization on the farm and synchronization of labor demands and helps to minimize discrepancies between different segments of the agricultural labor market. At the same time, self-organization of actors around *ad hoc* labor market arrangements should be guaranteed.

The perspectives gleaned from the International Symposium on Work in Agriculture (2nd

version in 2021) showcase pertinent issues weathering the future of work in agriculture in developing and developed countries, particularly in the OECD countries: 1) the transition to more sustainable agriculture via agro-ecology and digitalization; 2) internal and international migration flows in rural areas and protection of migrants; 3) the role of agricultural policies and labor regulations; 4) ethnic inequalities and working conditions; 5) the active emergence of women in the workplace and the social recognition of agricultural professionals; 6) the development of value chains that influence changes in agricultural practices and exchanges with other sectors; 7) bolstering labor productivity, especially in sub-Saharan countries, by offering attractive and decent working conditions to the young population that will have the highest growth rates in the world between 2030 and 2050 (Dedieu *et al.*, 2022).

Multiple key limitations hinder deeper analysis of the agricultural labor market, highlighting the need for future research on topics such as worker behavior through qualitative methods within a behavioral economics framework, and labor contracts for women, migrants, and vulnerable groups within the segmented agricultural labor market. The concepts of decent work and job satisfaction represent a significant avenue for exploration, helping to identify factors that could enhance the attractiveness of agricultural employment for youth. Santhanam-Martin *et al.* (2024) provide a framework for applying decent work principles to enhance employee satisfaction and retention in the Australian orchard industry amid labor shortages. Grounded in psychological contract theory, the study evaluates employees' perceptions of employer promise fulfillment across six major items, compared to the International Labour Organization (ILO) decent work domains, including safety and security, autonomy, resources to perform quality work, opportunities for training and skill development, employee benefits and increased responsibilities. The authors suggest broadening this framework to other dimensions like equal opportunity and social dialogue to better align with the Global Sustainable Development Agenda's commitment to decent work.

Acknowledgements

We would like to warmly thank all the farmers, workers, resource persons and public institutions who provided us with information about the study area and shared with us their valuable local knowledge. We would also like to thank Ms. Amina Raggas, Mr. Alaeddine Derderi, and Mr. Mohamed-Amine Lakhal for their help and their comments and criticisms on the paper.

References

- Adair P., Bellache Y., 2018. Labor market segmentation and occupational mobility in Algeria: Repeated cross-sectional and longitudinal analyses (2007 to 2012). *Review of Development Economics*, 22(4): 1765-1783. <https://doi.org/10.1111/rode.12519>.
- Amichi F., Bouarfa S., Lejars C., Kuper M., Hartani T., Daoudi A., Amichi H., Belhamra M., 2015. Des serres et des hommes : des exploitations motrices de l'expansion territoriale et de l'ascension socioprofessionnelle sur un front pionnier de l'agriculture saharienne en Algérie. *Cahiers Agricultures*, 24(1): 11-19. <https://doi.org/10.1684/agr.2015.0736>.
- ANSEJ (National Youth Employment Support Agency of the wilaya of Biskra), 2018. *Projects financed by sector of activity and by municipality between 1998 and 31/07/2018*.
- Barral S., 2014. Paternalistic Supervision of Labour in Indonesian Plantations: Between Dependence and Autonomy. *Journal of Agrarian Change*, 14(2): 240-259. <https://doi.org/10.1111/joac.12063>.
- Barral S., 2017. Chapitre 4 - Travail précaire, travail permanent, travail indépendant. Diversité et coexistence des formes de travail dans l'agriculture de plantation. In: Purseigle F., Nguyen G., Blanc P. (eds), *Le nouveau capitalisme agricole : De la ferme à la firme*. Paris: Presses de Sciences Po, pp. 125-152. <https://doi.org/10.3917/scpo.purse.2017.01.0125>.
- Batawila G.D., Pleines T., 2010. *Etude sur la main d'œuvre agricole au Togo et au Bénin*. Fribourg - Lomé: Brücke / Le pont - CRISTO, 47 pp. <https://docplayer.fr/9129084-Main-d-oeuvre-agricole-au-togo-et-au-benin.html>.
- Bedrani S., Cheriet F., 2012. Quelques éléments pour un bilan d'un demi siècle de politiques agricoles et rurales. *Les cahiers du CREAD*, 28(100): 137-162. <https://www.asjp.cerist.dz/en/article/2053>.
- Bessaoud O., 2006. La stratégie de développement rural en Algérie. In: Chassany J.P., Pellissier J.-P. (eds.), *Séminaire sur les Politiques de Développement Rural Durable en Méditerranée dans le Cadre de la Politique de Voisinage de l'Union Européenne*, "Options Méditerranéennes : Série A. Séminaires Méditerranéens", n. 71. Montpellier : CIHEAM, pp. 79-89. <https://om.ciheam.org/article.php?IDPDF=6400059>.
- Bessaoud O., Pellissier J.-P., Rolland J.-P., Khechimi W., 2019. *Rapport de synthèse sur l'agriculture en Algérie*. Montpellier: CIHEAM-IAMM, 81 pp. http://www.iamm.ciheam.org/ress_doc/opac_css/doc_num.php?explnum_id=18246.
- Bignebat C., Delame N., Hugonnet M., legagneux B., Nguyen G., Piet L., 2019. Partie 1 - Trois tendances structurantes : concentration, sous-traitance et diversification des exploitations. In: Forget V., Depeyrot J.N., Mahé M., Midler E., Hugonnet M., Beaujeu R., Grandjean A., Hérault B. (eds.), *Actif'Agri. Transformations des emplois et des activités en agriculture*. Paris: La Documentation Française, pp. 31-47. <https://hal.inrae.fr/hal-02437659>.
- Blanc M., Perrier-Cornet P., 1999. Emploi agricole : les cadres d'analyse à l'épreuve des dynamiques actuelles. *Économie rurale*, 253: 8-14. <https://doi.org/10.3406/ecoru.1999.5107>.
- Bouammar B., 2010. *Le développement agricole dans les régions sahariennes. Etude de cas de la région de Ouargla et de la région de Biskra (2006-2008)*. PhD thesis, University Kasdi Merbah - Ouargla, Algeria, 296 pp. https://www.raddo.org/content/download/19401/419572/version/2/file/THESE_DOCTORAT_BOUAMMAR_BOUALEM_Disk-Station_Aug-13-0917-2015_Conflict.pdf.
- Cahuc P., Carcillo S., Zylberberg A., 2014. *Labor Economics*, 2nd edition. Cambridge (MA): The MIT Press, 1043 pp.
- Charlton D., Taylor J.E., 2016. A Declining Farm Workforce: Analysis of Panel Data from Rural Mexico. *American Journal of Agricultural Economics*, 98(4): 1158-1180. <https://doi.org/10.1093/ajae/aaw018>.
- Christiaensen L., Rutledge Z., Taylor J.E., 2021. Viewpoint: The future of work in agri-food. *Food Policy*, 99: 12. <https://doi.org/10.1016/j.foodpol.2020.101963>.
- Colin J.-P., 2002. Contrats agraires ou conventions agraires ? *Économie rurale*, 272: 57-73. <https://doi.org/10.3406/ecoru.2002.5357>.
- Colin J.-P., 2003. *Figures du métayage : étude comparée de contrats agraires au Mexique*. Paris: IRD Editions, 355 pp.
- Daoudi A., 2016. Le financement informel du secteur maraîcher en Algérie : le cas du crédit fournisseur. *Techniques Financières et Développement*, 124/125: 107-116. <https://doi.org/10.3917/tfd.124.0107>.
- Daoudi A., Colin J.-P., Derderi A., Ouendeno M.L.,

2017. Le marché du faire-valoir indirect vecteur de nouvelles formes d'exploitation dans la néo-agriculture saharienne (Algérie). *Géographie, économie, société*, 19: 307-330. <https://doi.org/10.3166/ges.19.2017.0015>.
- Darpeix A., 2013. La main-d'œuvre salariée en agriculture : histoire d'une invisibilité, *Le Déméter 2013 : économie et stratégies agricoles*. Paris: Club Déméter, pp. 269-296. https://www.clubdemeter.com/_files/ugd/f650b7_b638fdc49fda46618bdc-1cdbc07db2a4.pdf.
- Didieu B., 2019. Transversal views on work in agriculture. *Cahiers Agricultures*, 28(8): 9. <https://doi.org/10.1051/cagri/2019008>.
- Didieu B., Nettle R., Schiavi S.M.d.A., Sraïri M.T., Malanski P.D., 2022. Which perspectives for work in agriculture? Food for thought for a research agenda. *Frontiers in Sustainable Food Systems*, 6: 14. <https://doi.org/10.3389/fsufs.2022.857887>.
- DPSB (Budget Programming and Monitoring Directorate of the Wilaya of Biskra), 2017. *Monography of the Wilaya of Biskra - 2016*. Algeri, 205 pp.
- DSA (Directorate of Agricultural Services of the Wilaya of Biskra), 2017. *Statistics on agricultural production by municipalities in the wilaya of Biskra*.
- Duval J.E., Blanconnet A., Hostiou N., 2021. How agroecological farming practices reshape cattle farmers' working conditions. *Agroecology and Sustainable Food Systems*, 45(10): 1480-1499. <https://doi.org/10.1080/21683565.2021.1957062>.
- ETF (European Training Foundation), 2021. *Youth in transition in the Southern and Eastern Mediterranean: Identifying profiles and characteristics to tap into young people's potential*, Turin, 129 pp. <https://www.ETF.europa.eu/en/publications-and-resources/publications/youth-transition-southern-and-eastern-mediterranean>.
- Geleta D.H., Alemayehu M., Asrade G., Mekonnen T.H., 2021. Low levels of knowledge and practice of occupational hazards among flower farm workers in southwest Shewa zone, Ethiopia: a cross-sectional analysis. *BMC Public Health*, 21(232): 12. <https://doi.org/10.1186/s12889-021-10254-5>.
- Hammouda N.-E., Souag A., 2012. *Segmentation du marché du travail en Algérie et la détermination du salaire dans les secteurs agricole, moderne non protégé et modernes protégé*. Working Papers n. 699, Cairo, Economic Research Forum, 17 pp. <https://erf.org.eg/app/uploads/2014/08/699.pdf>.
- Harris J.R., Todaro M.P., 1970. Migration, Unemployment and Development: A Two-Sector Analysis. *The American Economic Review*, 60(1): 126-142. <https://www.jstor.org/stable/1807860>.
- Hertz T., Zahniser S., 2013. Is There A Farm Labor Shortage? *American Journal of Agricultural Economics*, 95(2): 476-481. <https://doi.org/10.1093/ajae/aas090>.
- Huffman W.E., 2001. Chapter 7 - Human capital: Education and agriculture. In: Gardner B.L., Rausser G.C. (eds), *Handbook of Agricultural Economics*, vol. 1A, 1st ed. Amsterdam: Elsevier, pp. 333-381. [https://doi.org/10.1016/S1574-0072\(01\)10010-1](https://doi.org/10.1016/S1574-0072(01)10010-1).
- Huffman W.E., 2014. Volume 1 A - Agricultural Labor: Demand for Labor. In: Van Alfen N.K. (ed.), *Encyclopedia of Agriculture and Food Systems*, vol. 1, 2nd ed. Oxford: Academic Press, pp. 105-122. <https://doi.org/10.1016/B978-0-444-52512-3.00100-5>.
- ILO (International Labour Organization), 2021. *Employment in agriculture, industry and services, and total and youth of 15-24 years old unemployment rates*. <https://data.worldbank.org> (accessed on March 21, 2023).
- ILO (International Labour Organization), 2022. *Decent work deficits among rural workers: Key findings and recommendations for trade unions*. Switzerland: Bureau for Workers' Activities (ACTRAV), 45 pp. https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---actrav/documents/publication/wcms_850582.pdf.
- International Monetary Fund, 2022. *Consumer price index (2010 = 100) - Algeria*. <https://data.worldbank.org/indicator/FP.CPI.TOTL?locations=DZ>. Accessed on July 1, 2023.
- Laouar N., Daoudi A., Dugue P., 2023. Les vendeurs d'intrants agricoles, des traducteurs locaux d'un système d'innovation agricole mondialisé. Cas du maraîchage sous serre à Biskra (Algérie). *Les cahiers du CREAD*, 39(2): 177-200. <https://doi.org/10.4314/cread.v39i2.6>.
- Lassassi M., Hammouda N.-E., 2012a. Le fonctionnement du marché du travail en Algérie : population active et emplois occupés. *Région et Développement*, 35: 99-120. https://regionetdeveloppement.univ-tln.fr/wp-content/uploads/6_LASSASSI.pdf.
- Lassassi M., Hammouda N.-E., 2012b. 50 ans d'indépendance : quelle évolution de la situation du marché du travail en Algérie ? *Les cahiers du CREAD*, 28(100): 101-136. <https://www.asjp.cerist.dz/en/article/2052>.
- Lewis W.A., 1954. Economic Development with Unlimited Supplies of Labour. *The Manchester School*, 22(2): 139-191. <https://doi.org/10.1111/j.1467-9957.1954.tb00021.x>.
- Madelrieux S., Dupré L., Rémy J., 2009. Itinéraires croisés et relations entre éleveurs et salariés dans

- les Alpes du Nord. *Économie rurale. Agricultures, alimentations, territoires*, 313-314: 6-21. <https://doi.org/10.4000/economierurale.2367>.
- MADR (Ministry of Agriculture and Rural Development), 2019. *Agricultural statistics. Agricultural areas and productions*. Series B-2016. Algeri, 86 pp. <https://madr.gov.dz/wp-content/uploads/2022/04/SERIE-B-2016.pdf>.
- MADR (Ministry of Agriculture and Rural Development), 2021. *Agricultural statistics. Agricultural areas and productions*. Series B-2019. Algeri, 87 pp. <https://madr.gov.dz/wp-content/uploads/2022/04/SERIE-B-2019.pdf>.
- Malanski P.D., Dedieu B., Schiavi S., 2021. Mapping the research domains on work in agriculture. A bibliometric review from Scopus database. *Journal of Rural Studies*, 81(75): 305-314. <https://doi.org/10.1016/j.jrurstud.2020.10.050>.
- Malanski P.D., Schiavi S., Dedieu B., 2019. Characteristics of “work in agriculture” scientific communities. A bibliometric review. *Agronomy for Sustainable Development*, 39(36): 16. <https://doi.org/10.1007/s13593-019-0582-2>.
- Malanski P.D., Schiavi S.M.d.A., Dedieu B., 2022. Le travail en agriculture dans la littérature académique internationale (2010–2019). *Cahiers Agricultures*, 31(27): 10. <https://doi.org/10.1051/cagri/2022021>.
- Martin P., 2007. *Farm Labor Shortages: How Real? What Response?*. Backgrounder reports. Washington D.C.: Center for Immigration Studies, 15 pp. <https://cis.org/sites/cis.org/files/articles/2007/back907.pdf>.
- Martin P., 2014. Volume 1 A - Agricultural Labor: Labor Market Operation. In: Van Alfen N.K. (ed.), *Encyclopedia of Agriculture and Food Systems*, Vol. 1, 2nd edition. Oxford: Academic Press, pp. 131-142. <https://doi.org/10.1016/B978-0-444-52512-3.00102-9>.
- Merouani W., El Moudden C., Hammouda N.E., 2021. Social Security Enrollment as an Indicator of State Fragility and Legitimacy: A Field Experiment in Maghreb Countries. *Social Sciences*, 10(7): 25. <https://doi.org/10.3390/socsci10070266>.
- Morice A., Michalon B., 2008. Les migrants dans l'agriculture : vers une crise de main-d'oeuvre ? *Études rurales*, 182: 9-28. <https://doi.org/10.4000/etudesrurales.8749>.
- Mundler P., Laurent C., 2003. Flexibilité du travail en agriculture : méthodes d'observation et évolutions en cours. *Ruralia. Sciences sociales et mondes ruraux contemporains*, 12/13: 18. <https://journals.openedition.org/ruralia/pdf/336>.
- Musette M.S., 2014. *Employment policies and active labour market programmes in Algeria*. European Training Foundation (ETF). Turin, 35 pp. https://www.etf.europa.eu/sites/default/files/m/3F-6D27A7987C47FEC1257CE60024C937_Employment%20policies_Algeria.pdf.
- Naouri M., Hartani T., Kuper M., 2015. Mobilités des jeunes ruraux pour intégrer les nouvelles agricultures sahariennes (Biskra, Algérie). *Cahiers Agricultures*, 24(6): 379-386. <https://doi.org/10.1684/agr.2015.0778>.
- NASA, 2023. *Agroclimatology data for the location of M'ziraâ “Latitude 34.7288 Longitude 6.2953” from 1981 to 2022*. <https://power.larc.nasa.gov/data-access-viewer> (accessed on March 21, 2023).
- Omari C., Moissoner J.-Y., Alpha A., 2012. L'agriculture algérienne face aux défis alimentaires. Trajectoire historique et perspectives. *Revue Tiers Monde*, 210: 123-141. <https://doi.org/10.3917/rtm.210.0123>.
- ONS (National Office of Statistics), 2001. *La population active et le niveau de chômage au 07-09-2001*. <https://www.ons.dz/spip.php?article64> (accessed on August 30, 2023).
- ONS (National Office of Statistics), 2017. *Activity, Employment & Unemployment (September 2017)*. Employment and Unemployment, 796. Algeria, 20 pp. https://www.ons.dz/IMG/pdf/Activite_emploi_et_chomage_Septembre_2017.pdf (accessed on February 2, 2018).
- ONS (National Office of Statistics), 2019. *Activity, Employment & Unemployment (May 2019)*. Employment and Unemployment, 879. Algeri, 20 pp. https://www.ons.dz/IMG/pdf/emploi_chom_mai_2019.pdf.
- ONS (National Office of Statistics), 2021a. *Chapter 2 - Employment. Statistical Retrospective 1962 - 2020*, Algeri, pp. 65-96. https://www.ons.dz/IMG/pdf/CH2_Emploi1962_2020Fr.pdf.
- ONS (National Office of Statistics), 2021b. *Chapter 3 - Wages. Statistical Retrospective 1962 - 2020*. Algeri, pp. 97-113. https://www.ons.dz/IMG/pdf/CH3_Slaire1962_2020Fr.pdf.
- Ouendeno M.L., 2022. L'institution du métayage au Ziban (Algérie) et le développement de cultures maraîchères sous serres. *Alternatives Rurales*, 9: 3-24. <https://doi.org/10.60569/9-A1>.
- Ouendeno M.L., Daoudi A., Colin J.-P., 2015. Les trajectoires professionnelles des jeunes dans la néo-agriculture saharienne (Biskra, Algérie) revisitées par la théorie de l'agricultural ladder. *Cahiers Agricultures*, 24(6): 396-403. <https://doi.org/10.1684/agr.2015.0793>.
- Perrot A., 1992. *Les nouvelles théories du marché du travail*. Paris: La Découverte, 125 pp.

- Ragkos A., Koutsou S., Theodoridis A., Manousidis T., Lagka V., 2018. Labor management strategies in facing the economic crisis. Evidence from Greek livestock farms. *New Medit*, 17(1): 59-71. <https://doi.org/10.30682/nm1801f>.
- Richards T.J., 2018. Immigration Reform and Farm Labor Markets. *American Journal of Agricultural Economics*, 100(4): 1050-1071. <https://doi.org/10.1093/ajae/aay027>.
- Richards T.J., Patterson P.M., 1998. Hysteresis and the Shortage of Agricultural Labor. *American Journal of Agricultural Economics*, 80(4): 683-695. <https://doi.org/10.2307/1244056>.
- Sabillón B.H., Gerster-Bentaya M., Knierim A., 2022. Measuring farmers' well-being: Influence of farm-level factors on satisfaction with work and quality of life. *Journal of Agricultural Economics*, 73: 452-471. <https://doi.org/10.1111/1477-9552.12457>.
- Santhanam-Martin M., Wilkinson R., Cowan L., Nettle R., 2024. Elaborating Decent Work for Agriculture: Job Experiences and Workforce Retention in the Australian Orchard Industry. *Journal of Rural Studies*, 111: 9. <https://doi.org/10.1016/j.jrurstud.2024.103330>.
- Sraïri M.T., A., B Naqach Y., 2022. Comparing the uses of available labor and capital in diversified farming systems in Drâa oases (Morocco). *New Medit*, 21(5): 21-34. <https://doi.org/10.30682/nm2205b>.
- Taylor J.E., 2010. Agricultural Labor and Migration Policy. *Annual Review of Resource Economics*, 2: 369-393. <https://doi.org/10.1146/annurev-resource-040709-135048>.
- Taylor J.E., Charlton D., 2019a. Chapter 8 - The End of Farm Labor Abundance. In: Taylor J.E., Charlton D. (eds.), *The Farm Labor Problem: A Global Perspective*. Oxford: Academic Press, pp. 181-204. <https://doi.org/10.1016/B978-0-12-816409-9.00008-2>.
- Taylor J.E., Charlton D., 2019b. Chapter 6 - Farm Labor and Immigration Policy. In: Taylor J.E., Charlton D. (eds.), *The Farm Labor Problem: A Global Perspective*. Oxford: Academic Press, pp. 121-154. <https://doi.org/10.1016/B978-0-12-816409-9.00006-9>.
- Taylor J.E., Charlton D., 2019c. Chapter 9 - Robots in the Fields. In: Taylor J.E., Charlton D. (eds.), *The Farm Labor Problem: A Global Perspective*. Oxford: Academic Press, pp. 205-225. <https://doi.org/10.1016/B978-0-12-816409-9.00009-4>.
- Tocco B., Davidova S., Bailey A., 2012. *Key Issues in Agricultural Labour Markets: A Review of Major Studies and Project Reports on Agriculture and Rural Labour Markets*. Factor Markets Working Papers, 20. Brussels: CEPS, 38 pp. http://aei.pitt.edu/58523/1/Factor_Markets_20.pdf.
- Vercherand J., 2014. *Labour: A Heterodox Approach*. London: Palgrave Macmillan, 214 pp.
- Vincq J.-L., Granié A.-M., 2014. Chapitre 9 - Les figures du salariat agricole : le cas du secteur des fruits et légumes en Languedoc-Roussillon. In: Jeanneaux P., Perrier-Cornet P. (eds.), *Repenser l'économie rurale*. Versailles: Éditions Quæ, pp. 142-154. <https://doi.org/10.3917/quae.jean.2014.01.0142>.
- Wane A., Touré I., Njiru N., Mballo A.D., 2018. Securing Sahelian pastoralism by using a remunerated workforce for livestock keeping activities: the ambivalence of commodification. *Cahiers Agricultures*, 27(3): 6. <https://doi.org/10.1051/cagri/2018024>.
- Wheeler R., Nye C., 2024. The Health and Well-Being of Women in Farming: A Systematic Scoping Review. *Journal of Agromedicine*: 1-21. <https://doi.org/10.1080/1059924X.2024.2407385>.
- Zajdela H., 1990. Le dualisme du marché du travail : enjeux et fondements théoriques. *Économie & prévision*, 92-93: 31-42. <https://doi.org/10.3406/ecop.1990.5155>.