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Securing Sahelian pastoralism by using a remunerated workforce for livestock keeping activities: the ambivalence of commodification

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Abstract – Sahelian pastoralists use mobility, diversification, and even pluriactivity as main adaptation strategies to the asymmetrical distribution of multifaceted resources. Complex relations vis-à-vis this risky environment hide slowing transitions from a traditional inward-looking to an outward-looking economy, which is characterised by increasing use of a remunerated workforce. The growing commodification of the economy of Sahelian pastoralists could generate new forms of uncertainty. The authors of this paper use a principal-agent model to analyse the remunerated workforce and demonstrate the mixed results of this strategy in the context of structural risk in the Sahel. The authors then highlight the conditions under which trust and reputation are developed to stabilise employment relations and better cope with and/or mitigate various shocks.

Keywords: pastoralism / risk / remunerated workforce / commodification / Sahel

Résumé – La sécurisation des activités pastorales au Sahel à travers le recours à la main-d'œuvre rémunérée : l'ambivalence de la marchandisation. Les pasteurs sahéliens utilisent la mobilité, la diversification, voire la pluriactivité comme principales stratégies d'adaptation face à la distribution asymétrique de ressources multiples. La complexité des interactions avec cet environnement risqué cache des transitions progressives d'une économie centrée sur les ressources familiales vers une économie plus ouverte à travers un recours croissant à de la main-d'œuvre salariée. Cette marchandisation accrue peut générer de nouvelles formes d'incertitudes. Cette contribution utilise un modèle principal-agent pour analyser le recours à de la main-d'œuvre salariée et montrer l'ambivalence de cette stratégie dans le contexte de risques structurels du Sahel. Elle décrit ensuite les modalités de production de confiance et de réputation pour stabiliser les relations salariales et faire face à ces incertitudes.

Mots clés : pastoralisme / risque / main-d'œuvre salariée / marchandisation / Sahel

1 Introduction

Hazards are ubiquitous in the lives of most people, notably in those of farmers in developing countries, who must act to secure their livelihoods and minimise losses. Those with weak assets are usually pushed to engage in low return and sometimes risky nonfarming activities (Barrett *et al.*, 2001), whereas for others more endowed or living in regions with favourable alternative activities, the impetus to raise incomes and accumulate wealth prevails (Loison and Loison, 2016). Sometimes they adopt the rearing of short cycle species (sheep and goats), which provides fast gains to escape poverty (Alary *et al.*, 2015). Sahelian pastoralists are facing increasing shocks, constraints and risks. They lack contingent markets for their produce, which affects their livelihoods severely. They are gradually adapting to these conditions by using mobility and diversification/multifunctionality strategies to enhance production and secure their livelihoods (Alary *et al.*, 2015). These strategies are characterised by complex relations that limit multi-level strategies, including the use of remunerated workers, thus overtaking the delegation of tasks usually handled at the family level.

The use of remunerated employees is meant to complement cattle herding and mobility while developing and improving remunerated workforce relations and also to support on-going

Table 1. Livestock risk assessment in Senegal and risk prioritisation in the Ferlo region.

Tableau . *Évaluation des risques dans le secteur de l'élevage au Sénégal et priorisation au Ferlo.*

Risks related to	Worse-case scenario	Average frequency	Average annual losses	Score[1]	Ferlo's risk prioritization
Bush fires	Very significant	Very significant	Very significant	5	High
Animal health	Very significant	Significant	Very significant	4.6	Average
Rainfall	Very significant	Medium	Significant	3.84	Average
The market	Low	Significant	Low	2.62	Average
Conflicts	Medium	Very low	Low	1.81	High
Plagues of locusts	Very low	Very low	Low	1.31	Weak

Source: Wane and Mballo (2016).

[1] Risk scores are based on the evaluation of the frequency and severity of risks, then ranked in order of significance:

Score risk $= 0.75 \times$ (Average losses $\times$ frequency)$^{0.5} + 0.25 \times$ Severe losses.

herd management. More broadly, this implicitly reflects an increased commodification of social relations and practices in pastoral areas. Commodification should be neutral in terms of emerging uncertainties as the payment of a fixed salary seems to be the best option for all stakeholders involved in the transaction. However, information asymmetry among stakeholders is common and can be a source of moral hazard because efforts from the players' transactions are endogenous, but adverse selection may also arise. In such cases, in-depth investigations should be conducted to determine how Sahelian pastoral settlements manage remunerated employees in a context of inaccurate information and especially in a context of increased commodification of pastoral activities.

The authors of this paper analyse the pre-conditions for the development of trust and reputation (Tirole, 1996; Gergaud *et al.*, 2012), without which cooperative strategies would be difficult to implement, as prominently expressed in the Kreps-Milgrom-Roberts-Wilson model (Kreps *et al.*, 1982).

Section 2 describes the study area and shows the nature of the risks pastoralists are facing. Section 3 relies heavily on previous studies conducted and published in 2009 and 2010 to recall the explanatory factors of the use of a remunerated workforce in the Senegalese Sahel before pointing out an emerging research question concerning the mixed results of this strategy. In Section 4, the authors elaborate on the theoretical modelling and explain the methodological approach used to address emerging issues of employment relations in Sahelian pastoral regions. Section 5 describes the conditions for production of trust and reputation that cement employment relations in the Sahelian pastoral areas. A conclusion is drawn in Section 6.

2 Study area and risk assessment

The Ferlo is the main pastoral farming zone in Senegal, which covers a vast area of 67 610 km². It faces erratic rainfall, with annual averages below 200 mm in the north and above 550 mm in the south. Pastoral farming is the principal mode of economic valuation in these arid areas, and livestock keepers are operating in a context of risk. Mobility is gradually being recognized as an adaptation to environmental conditions, and it also facilitates the securing of livestock and encourages the increased use of hired labour. Pastoral households in the Ferlo attach high value to animal production management. They

commit 98% of their time to herd management (through watering, milking and transhumance), and the rest of their time is spent on other *ad hoc* tasks (such as salt curing meat) (Wane *et al.*, 2009).

Risk assessment and prioritisation conducted on behalf an International Fund for Agricultural Development (IFAD) survey (Wane and Mballo, 2016) showed that the main risks in the Senegalese Sahel are related to conflicts and bush fires, whereas those related to animal diseases, rainfall as well as livestock and commodity market have average impacts (Tab. 1). However, this computable risk approach could be differently perceived by pastoralists who are usually acting in uncertainty.

3 Preliminary findings on a remunerated workforce in Ferlo and emerging research question

As described by Wane *et al.* (2009, 2010), the quantitative data gathered for this research came from existing databases collected between June 2006 and June 2007 using questionnaires on a subset of 149 pastoral encampments from five sites (Boulal, Keur Momar Sarr, Niassanté, Tatki and Thieul). A pastoral encampment is a large unit of residence grouping one or more households.

Results show that 25% of pastoral settlements declare that they use a remunerated workforce. These findings contribute to the revision of the idea that Sahelian pastoralism is an economic activity based solely on family labour. In these pastoral farms, production and sales decisions are often disconnected from market imperatives. Therefore, the use of remunerated labour stems from multiple trade-offs between internal work organisation, family activities and livestock-based income (Tab. 2).

The authors applied a logistic regression model to the data, the findings of which revealed that the use of remunerated labour is negatively determined by the number of households in the encampments (very significant at 1%) and the labour transfer rate (the ratio between the number of encampment members declaring remunerated external activities and the total population; very significant at 5%). In addition, it is positively influenced by the number of sheep in the herd, so that their management quickly becomes time-consuming (very significant at 1%), the number of women living in the

Table 2. Determinants of pastoral wage labor in the Ferlo (Wane *et al.*, 2010).
Tableau . *Déterminants du recours à la main-d'œuvre salariée au Ferlo (Wane* et al*., 2010).*

	Variables	B	E.S.	Exp(B)	Odd ratios [Exp(B) − 1] × 100 (%)	Nagelkerke's pseudo R-squared (%)
"Gender" model	Household[***]	−0.476	0.171	0.621	−37.9	42.0
	Woman[**]	0.123	0.061	1.131	13.1	
	Labor transfer[***]	−2.975	1.146	0.051	−94.9	
	Cattle[**]	0.012	0.006	1.012	1.2	
	Sheep[***]	0.009	0.003	1.009	0.9	
	Constant	3.042	2.228	20.956	−	
"Age group" model	Household[***]	−0.494	0.182	0.610	−39.0	42.4
	Third Age[*]	0.309	0.168	1.362	36.2	
	Cattle[**]	0.014	0.006	1.014	1.4	
	Sheep[***]	0.008	0.003	1.008	0.8	
	Labor transfer[***]	−3.213	1.177	0.040	−96.0	
	Constant	3.719	2.274	41.222	−	

The Nagelkerke's pseudo R-squared, adjusted version of Cox & Snell's pseudo R-squared, is more relevant in our case.
Non-significant variables are not shown in this table.
[***] Significant at 1%.
[**] Significant at 5%.
[*] Significant at 10%.

encampment (very significant at 5%) and the number of people aged over 50 years living in the encampment (very significant at 10%).

During the dry season in the arid Ferlo, pastoral households hire seasonal or permanent labour for transhumance. The number of employees hired depends on the herd size; large livestock keepers employ many employees (69%) and have a lower labour transfer rate (9%) because they have enough financial resources to own large herds and hire many employees. Conversely, small livestock producers have insufficient financial resources to own large herds and remunerate employees. There is high labour loss in this last category (a labour transfer rate of 33%). In the intermediate categories of 'large livestock keepers' and 'medium livestock keepers', the situation is mixed. There is a need for livestock producers to seize opportunities in the region and earn a decent income from the production of animals.

Almost 87% of respondents identified (1) technical factors (of herd composition in terms of species and herd management) and (2) individual aspirations as factors motivating them to use remunerated labour. Another factor influencing the recourse to remunerated labour includes land use; 54% of employers cite the use of a remunerated workforce to prevent neighbourhood conflicts. In the southern Ferlo, in agropastoral sites such as Boulal and Thiel, nearly 81% of employers declare that use of remunerated labour frees up time for other income generation activities. Economic diversification is mainly in the form of trading, particularly in the site of Boulal, which is very close to the larger livestock market (Dahra), and in the site of Thiel, which is closer to the Groundnut Basin.

However, the use of remunerated labour is itself a source of uncertainty that producers are trying to reduce. In the informal context of Ferlo, this strategy contributes to the increased commodification of social transactions and is also a source of new uncertainties.

4 Theoretical framework and methodological approach for addressing the emerging research question

Sahelian pastoral households still pursue a composite utility function that balances their short-term consumption needs and long-term herd building strategies to meet future consumption needs (Fadiga, 2013). Pastoralists are not systematically monetary-oriented. The use of a remunerated workforce is common in Sahelian pastoral areas and their issues could be addressed by the principal-agent approach to explain the relations between employers (pastoralists) and employees (shepherds).

4.1 A basic principal-agent model as an analytical framework

In the principal-agent relationship, an economically dependent entity, referred to as the agent, manages the assets of another economically strong entity called the principal. The principal must provide compensation without having accurate information about the agent's efforts (Mirrlees and Raimondo, 2013). This model is based on the influential contribution of Holmström and Milgrom (1991), and its empirical implications in socioeconomic transactions are wide ranging. Although game theory tools in principal-agent modelling have led to sophisticated mathematical developments (Mirrlees and Raimondo, 2013), the authors of this paper have simplified the approach to the greatest possible extent, with results quite similar to those of Debraj (2012) and Corgnet *et al.* (2016).

Consider Q as the production level expected by both parties and e the level of effort $e_i \in \{0, 1\}$ exerted at a certain cost that influences the final output. For the principal, it is possible to have a low output Q' when the agent provides low level of effort

($e = 0$) and *vice versa*: a high output Q^e for a high level of effort ($e = 1$). The production Q depends on the agent's effort. It will be high enough to reach P_e when the agent provides great effort or low $p_f = 1 - p_e$ when he provides weak or no effort $0 < p_f < p_e < 1$.

$$Q = Q^f \quad \text{if} \quad e = 0 \quad \text{and} \quad p = p_f$$
$$Q = Q^e \quad \text{if} \quad e = 1 \quad \text{and} \quad p = p_e. \tag{1}$$

Effort production is not financially neutral for the agent; this cost $C = \begin{cases} C^f \\ C^e \end{cases}$ is both linked to the intrinsic effort level and incentives designed by the principal. It should be noted that the term 'incentives' could cover anything from a monetary payment against a measurable outcome to a reward (not only in monetary terms) against a measurable effort.

Thus, the agent utility depends on the wage level and the efforts made. Two conditions could influence this utility:

– a situation of fixed salary $\begin{cases} u(w) - C^e \\ u(w) - C^f \end{cases}$

– a situation of variable salary according to the efforts made by the agent: $\begin{cases} u(w_e) - C^e \\ u(w_f) - C^f \end{cases}$

Thus, how does one develop a contract with an optimum salary level to ensure the highest level of effort is provided by the agent?

The principal who aims at an effective control of scarce resources and production activities will offer incentives to influence the behaviour of the agent. Before hiring an agent, the principal must manage two constraints:

– a *participation constraint* (or *individual rationality* as notified by Varian, 2014): The agent must work before payment. This constraint ensures the agent's reservation utility (equivalent to what could give him another opportunity), and if there is another contractual option enabling the agent to obtain a utility $u(a)$, the principal must label the contract as follows:

$$\begin{cases} p_e u(w_e) + (1 - p_e) u(w_f) - C_e \geq u(a) \\ u(w) - C_e \geq u(a) \end{cases} \tag{2}$$

– an *incentive compatibility constraint* (or *self-selection* as stipulated by Varian, 2014), which says that the agent must receive a higher utility from exerting effort than for not doing so, as follows:

$$\begin{cases} p_e u(w_e) + (1 - p_e) u(w_f) - C_e \geq p_f u(w_e) + (1 - p_f) u(w_f) - C_f \\ u(w) - C_e \geq u(w) - C_f \end{cases}$$
$$\Longrightarrow \begin{cases} [u(w_e) - u(w_f)](p_e - p_f) \geq C_e - C_f \\ C_e \geq C_f \end{cases} \tag{3}$$

It is assumed that the agent is risk averse. Therefore, living under risk and random income, the agent's expected utility is lower than it would have been if he received a guaranteed income. The principal is risk neutral. He aims to design a contract that maximises his expected monetary or non-monetary return. The principal will also manage two problems:

– a hidden information problem, such as when the principal is unable to get information on whether the employee is skilled or not prior to hiring;
– a hidden action problem or moral hazard, which is a recurrent issue in fixed-salary contracts because the level of

effort required is not perfectly observable in advance by the principal.

Thus, the principal could elaborate a contract by assessing two possibilities:
– the case in which efforts made by the agent are observable (first-best contract) either directly by the principal or indirectly by a third party remunerated by the principal. The optimal contract would ensure a guaranteed payment $\overline{w}$ covering the participation and incentive compatibility constraints of the agent;
– the case in which efforts made by the agent are not observable (second-best contract). The principal considers a payment adjusted to the agent's effort. The dilemma would be to find a value between high payment $\overline{w}_e$ if the deliverable is satisfactory and lower payment $\overline{w}_f$ if the deliverable is not satisfactory to optimise the expected results while respecting the participation and incentive compatibility constraints of the agent.

In principal-agent transactions, the gains expected by the principal depend on the agent's actions and efforts to achieve the expected results. The agent's effort is key in principal-agent transactions, and many theoretical contributions have analysed which incentives motivate the agent to provide efforts adequate for a given production level (Holmström and Milgrom, 1991). Although the agent's efforts are positively correlated with the final outputs, the occurrence of random exogenous shocks affects the agent's efforts to achieve the expected results (Rubin and Sheremeta, 2015). These studies have also examined the best way to design an optimal contract in an inaccurate information situation, but only a few of them have analysed income related to the presence of hazards and resulting from the agent's efforts (Rubin and Sheremeta, 2015).

Moreover, economic agents could be selfish and motivated by the pursuit of personal interests. As a result, the contracting parties reciprocate this type of behaviour. Empirical studies have incorporated this form of positive and negative reciprocity by using game theory. Other empirical surveys show that 40 to 60% of individuals in contractual transactions make reciprocally beneficial choices, whereas 20 to 30% behave purely selfishly (Fehr *et al.*, 2007).

This paper mainly describes a static approach to the principal-agent models based on first-order solutions that could appear limited in their ability to provide more widely applicable economic solutions. However, dynamic approaches, although desirable, pose important technical challenges as bilevel optimisation problems (participation and incentive constraints). Recent research contributions have attempted to address the agent's optimisation problems by extending polynomial approaches for static principal-agent models to dynamic models (Renner and Schmedders, 2015).

Recruitment is primarily based on the reputation of the employee. Individuals invest in building good reputations for themselves, since they know they will be trusted in the future if they keep a clean record now. Reputation should be understood both individually and collectively, as stated by Tirole (1996) and empirically observed by Gergaud *et al.* (2012). Thus, an

individual may increase his level of effort to meet the standards of a collective reputation developed by former and existing community members. Therefore, individual effort level is also linked to the past behaviours of other members of the community. In addition, agent behaviours can be influenced by collective beliefs and socio-cultural practices (Tirole, 1996).

After recruitment, production uncertainties can emanate from the quality of production and employee behaviour. Thus, the stability of employment relations can also depend on the level of trust between employer and employee. Trust, often put forward by employers, is not spontaneously acquired but rather generated by individual motivations to maintain a reputation. By tracking the conditions of trust implementation, Reynaud (1998) emphasised a radical cleavage between approaches to cultivating confidence in terms of cumulative capital and in terms of immaterial trust.

5 Trust and reputation building processes in the context of commodification in the Sahel

In the Sahelian context, a breeder (the principal) recruits a shepherd (the agent) for herd management during the lean season, and sometimes in the rainy season, to control animals and prevent them from grazing in crop areas. This recruitment results in a predetermined wage remunerated according to the conditions of a gentleman's agreement between the contracting parties, made in the presence of witnesses.

5.1 Participation and incentive compatibility constraints

The participation constraint of the shepherd seems to be very low or even zero in Ferlo because labour supply is strong, and shepherds have a strong desire to increase their own herd by buying animals with gained wages.

In terms of incentive compatibility constraints, shepherd recruitment is built around a service in return for an in-kind contribution (a predetermined number of small ruminants to exchange and/or a certain amount of milk, as well as coverage of food and clothing expenditures) to encourage shepherds to manage animals effectively in a challenging environment characterised by scarce resources. However, monetisation in the form of a fixed salary complicates this constraint, as other incentives are required to avoid agent modulation of efforts. When agents are provided with a salary (rather than rewarded with the immediate fruits of their labor), they are more likely to search for (and find) ways to exert less effort while still achieving the same level of monetary compensation

5.2 Management of non-observable efforts

The average monthly wage is 17 389 FCFA (minimum 8000, maximum 24 000 – 1 \$ = 555 FCFA). The remuneration is monthly for over 72% of respondent employees. For 28% of them, it is done on an annual basis and often in-kind for others, with the employer agreeing at the beginning of the contract to provide the employee with a predetermined number of animals (Wane *et al.*, 2009). The establishment of a specific agreement based on the payment of a fixed salary in pastoral areas is likely to lead to further uncertainty and destabilisation of trust surrounding traditional forms of work. Therefore, the approach developed by Salais (1989) remains based on commodity production and might be partially applicable in the extensive farming systems of the Ferlo, where production is not fully developed, immediate or solely intended for the market (Wane *et al.*, 2009). Breeders in the Ferlo manage shepherds' efforts through a form of assessment based on endogenous knowledge. They make daily observations of the herd before and after grazing to monitor weight loss, milk production and animal behaviour (*e.g.*, restless, quiet) and control daily employee behaviour (rigor at work and in social relations). In addition, breeders also randomly visit the shepherd during transhumance to monitor and evaluate shepherds' efforts and behaviour.

Breeders manage uncertainty surrounding the equivalence between future work and wages by building conditions that generate trust and reputation.

5.3 Conditions for the production of trust and reputation

5.3.1 Reputation-based recruitment: geographical proximity and ethnicity criteria

Recruitments in the Ferlo region are based on locality and ethnicity. Employers enjoy high levels of trust and confidence with employees with whom they share the same locality and ethnic group. On average, 78% of employers hire Fulani employees, and 41% of them hire from their own ethnic group. Boulal, the region near the regional capital city of Dahra, revealed a higher percentage of these cases (83% of employees share a locality and ethnic group with their employers, and 67% of employees are from the same ethnic group as their employers). Employers rely on these signals to better manage recruitment-related hazards. The common ethnic group combined to religious belonging could play an important role in stabilizing social relationships as already observed in other areas (Greif, 1989).

5.3.2 Employer-employee relations

The relationships between employers and employees help establish and nurture trust. The employee is generally regarded as a family member of the employer who receives from the employer the resources required to meet its basic needs (food, shelter and clothing). This combination of monetary and non-monetary remuneration depends on the employee's status. Employees categorised as *gaynako* have more stable and sustainable employment contracts than *sourga* and *saardi* employees. Compensation for the latter two types of employees remains highly uncertain and highly subject to the intrinsic functioning rhythms of farming operations.

Sahelian pastoralists are aware of exogenous shocks and the diverse nature of shepherds' uncertainties; thus, breeders protect herds against the risks posed by these shocks, as well as those posed by shepherd behaviour.

6 Conclusion

Breeders in the Ferlo seek to reduce risks induced by the delegation of tasks by seeking confidence factors (recruitment in the ethnic sphere, even geographical and fractional recruitment), monitoring the level of effort of the employee (accompaniment by a family member) and controlling results (daily observations based on a proven system of traditional knowledge). Growing commodification to remunerate the workforce must also reduce asymmetries in employment relations, even if employers commonly use endogenous knowledge to implement trust and reputation building process and cope with uncertainties. How far do the pastoralists have to go to secure herd management using the labour of people hired from other families and communities?

Moreover, examination of the use of a remunerated workforce in Sahelian pastoral areas will illuminate the evolution of agricultural work and family farms. However, there is an obvious need to address these salary relationships by using a more dynamic model that takes into consideration the repeated actions and collects relevant data for this purpose. This would facilitate the exploration of a more stimulating perspective on the emerging question of wage labour in the primary sector of Sahelian pastoralism and, more broadly, its contribution to youth employment.

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