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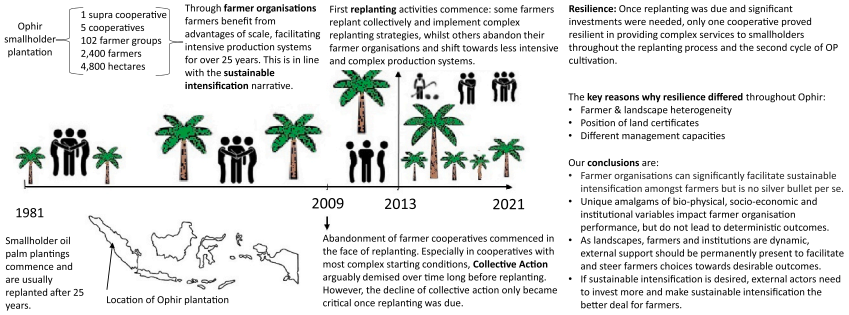
HIGHLIGHTS

- Collective action and farmer organisations are often presented as pathways to sustainable intensification and replanting.
- This article aims to provide insights into the resilience of farmer organisations and smallholder oil palm replanting.
- We demonstrate how bio-physical, socio-economic, and institutional variables impact the resilience of collective action.
- To unlock the potential of farmer organisations, broader collective action is essential, extending beyond smallholders.
- This article provides a unique, comprehensive analysis of farmer organisation dynamics spanning 40-years.

GRAPHICAL ABSTRACT



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ABSTRACT

CONTEXT: Oil palm smallholders often have difficulty implementing good agricultural practices and replanting, and tend to obtain low yields compared to corporate plantations. A frequent strategy to improve the sustainability of smallholder production systems is sustainable intensification, aimed at increasing land productivity and farmers' incomes. To facilitate sustainable intensification, many leading public and private sustainability initiatives require farmers to join farmer organisations as a precondition for certification and assistance, with the objective of achieving advantages of scale.

OBJECTIVE: The objective of this article is to analyse the resilience of farmer organisations in the Ophir plantation when faced with replanting. We do so by linking actors, situations, and contexts relevant to collective action in five farmer cooperatives in Ophir over a 40-year period. Our aim is to offer unique insights into the enduring dynamics that influence the resilience of farmer organisations, shed light on smallholder oil palm replanting strategies, and draw several key lessons from this case.

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METHODS: Our findings are based on field visits by the lead author before, during and after replanting. Both qualitative and quantitative data were collected to enable a holistic overview. During visits, 110 interviews with relevant stakeholders were recorded, project reports were collected, as were data on yields, costs, and other information on the functioning of the farming system. Analysis of high-resolution satellite imagery of the Ophir plantation and plantation inspections allowed us to further quantify replanting methods and replanting progress. A combined IAD-SES-NAS framework was used to structure findings and link variables, key events and context.
RESULTS AND CONCLUSIONS: Our results show that farmer organisations can facilitate sustainable intensification in smallholder systems, but the resilience of farmer organisations proved diverse during replanting. Thus, farmer organisations are by no means a silver bullet for sustainable intensification. Landscape conditions, palm tree age, smallholder diversity and financial (mis)management play crucial roles in the resilience of farmer organisations and replanting strategies. Significant investment in various types of collective action is needed to encourage sustainable intensification through farmer organisations.
SIGNIFICANCE: This article reports a rare holistic analysis of the bio-physical, socio-economic, and institutional aspects impacting collective action and replating in smallholder oil palm plantations. We present significant empirical data, which allows us to link 40 years of interactions between farmers, their institutions, plantations and changing contexts. Thereby we provide unique insights into farmer organisations, collective action and smallholder oil palm replanting.

1. Introduction

Oil palm is the largest single source of vegetable oil worldwide, with production of palm oil estimated at 72.9 million metric tons in 2020/2021. The world's largest producer of palm oil is Indonesia, which provides 59.7% of global supplies (USDA, 2022). Smallholders have played a critical role in oil palm expansion in Indonesia over the last 42 years; the land owned by smallholders planted to oil palm increased from 0 ha in 1978 to 6 million ha in 2020, and in the same year, smallholder plantations accounted for 40.4% of Indonesia's total oil palm area (DJP, 2020). Although oil palms provide incomes for millions in rural areas and play an important role in rural development in Indonesia (Bissonnette and De Koninck, 2017; Potter, 2016), smallholder land productivity is generally low compared to that of corporate oil palm plantations (Dalheimer et al., 2021; DJP, 2020; Monzon et al., 2021), due to frequent difficulty accessing knowledge, funding, agrochemicals, and markets (Cramb and McCarthy, 2016; Gellert, 2015; Potter, 2016). Support for and monitoring of production by smallholders has proven complex due to their large number, their lack of formal land ownership rights, and limited investments by the public and private sectors. What is more, the marked heterogeneity of oil palm smallholders and landscapes often makes 'one size fits all' solutions ineffective (Jelsma et al., 2017a; Mettauer et al., 2021; Sibhatu and Steinhübel, 2022).

This article focusses on the effects of a particular challenge for smallholders in the oil palm sector: replanting. Replanting after the first life cycle is a critical stage for all tropical perennial crops (Ruf, 2000). The life cycle of oil palms generally comprises a 3-year unproductive stage after planting, followed by increasing yields until peak production is reached between year 6 and 12, and decreasing yields thereafter (Fairhurst et al., 2019; Ismail and Mamat, 2002). Although affected by specific local conditions, maintenance, and prices for fresh fruit bunches (FFB), the raw material processed by palm oil mills, the economic life span of oil palms is usually about 25 years. Because companies are aware of this production curve, they usually begin replanting when the trees are 25 years old. They also replant in stages to limit shocks to the production system, to spread out the replanting cost over time, and to cover the 3-year period without income. However, smallholder awareness of declining yields over time is often limited, as are access to finance and high-quality planting material, such that smallholders are often ill-prepared for replanting (Hutabarat et al., 2018; Siregar et al., 2018). Because removing old palms can be costly, smallholders may be more interested in expanding their plantations than in replanting (thereby increasing deforestation) or may delay replanting, thereby accepting sub-optimal production conditions. With limited endowment, the poorest farmers are most at risk during the 3-year income gap, and are consequently more likely to sell their plantations or purchase poor planting materials, thereby severely limiting their yield potential from the outset. As a result, replanting involves considerable social as well as environmental risks (Hutabarat et al., 2018; Johnston et al., 2018; Siregar et al., 2018). Given that replanting is imminent for many farmers in Indonesia currently, this article is a timely contribution to the limited body of literature on smallholder oil palm replanting.

Leading sustainability initiatives, such as the private sector led Round Table on Sustainable Palm Oil (RSPO) and the public sector led Indonesian Sustainable Palm Oil initiative (ISPO), have developed strategies to improve smallholder performance. The Indonesian government also established the Crude Palm Oil fund (CPO fund) in which oil palm export levies are collected and subsequently distributed to support sector sustainability, including improving smallholder practices and supporting replanting (Luttrell et al., 2018; Nurfatriani et al., 2019).

A key tenet in the above-mentioned sustainability initiatives is the obligatory membership of smallholders in farmer organisations (FOs) (DJP, 2017; Hidayat, 2017; RSPO, 2017). FOs have long been an important tool in rural development, improving agricultural productivity and sustainability, and anti-poverty policies (Bijman and Wijers, 2019; Bizikova et al., 2020), with most benefits linked to achieving advantages of scale and consequently improved access to inputs, markets, external programmes, technology, funding, extension services, resource management, advocacy, and improved value chain transparency and certification (Bizikova et al., 2020; Hazell et al., 2010; Markelova et al., 2009). Indeed, there is evidence that smallholder organisations in the oil palm sector capitalise on these benefits, contribute to the common good, and serve the private interests of farmers by increasing their income and by increasing the resilience of their farms to various kinds of shocks and stresses (Hidayat et al., 2021; Hutabarat et al., 2019; Jelsma et al., 2017b).

FOs can be regarded as the formal expression of collective action (CA) among farmers; here CA is defined as voluntary actions taken by a group of people with the aim of pursuing a shared interest (Hellin et al., 2009; Markelova et al., 2009; Meinzen-Dick et al., 2004). In functional FOs there should be clear formal agreements on the rights and obligations of participants, and their actual implementation. In practice, however, properly functioning FOs, and CA more generally, often prove difficult to establish and maintain. Besides practical problems such as lack of markets, a viable business, capable managers and trust (Hellin et al., 2009; Markelova et al., 2009; Shiferaw and Muricho, 2011), short term individual interests and long term collective benefits often compete (Cieslik et al., 2021; Gavrilets, 2015; Reynolds, 2010). In such social dilemmas, rational individuals may choose not to contribute but rather to free-ride, whilst others may fear being taken advantage of and hence limit their contribution. Both of which may lead to the demise of collective benefits, or even in the destruction of the resource (Gavrilets, 2015; Hardin, 1968; Olson, 1965). Over the last 55 years, a vast body of

literature has emerged which systematically analyses CA. These studies usually involve the analysis of institutional arrangements, resource system characteristics, group characteristics and the external environments (Cox et al., 2010; Jagers et al., 2020; Ostrom, 1990) and confirm that CA has been successful in a vast range of long-term sustainable resource management situations (Gavrilets, 2015; Jagers et al., 2020; Ostrom, 1990).

Jelsma et al. (2017b) provided a detailed overview of CA, including well-functioning FOs, in a 4800-ha smallholder plantation named Ophir, in West Sumatra, which obtained high yields throughout the first production cycle. This plantation involved 2400 farmers, 102 farmer-groups (FGs), five cooperatives and a supra-cooperative. This institutional setup depended on the implementation of solidarity and subsidiarity principles; farmers and group-managers monitored and supported each other in plot maintenance, and cooperatives and the supra-cooperative provided services that were better organised at scale (see Appendix 1). With such apparently successful CAs, farmers appeared well-positioned to tackle replanting. However, Jelsma et al. (2017b) also reported that faced with replanting, many farmers began to leave their organisations and instead opted to become independent smallholders, but hinted that their abandonment of CA did not happen uniformly throughout Ophir.

This article picks up where Jelsma et al. (2017b) left off by analysing the resilience of collective action in the face of replanting and by evaluating outcomes. It explores how and why resilience manifested itself differently across the plantation, and what the consequences of these discrepancies are. We focus on the role of cooperatives, as this is where the subsidiary services from the FOs in Ophir are most evident (see Appendix 1). To structure our analysis and to identify relevant policy intervention strategies, we used the combined IAD-NAS-SES framework, which is explained in the Research Approach section.

The remainder of this article is structured as follows. Section 2 presents our theoretical framework and methods, while Section 3 gives a brief introduction of the Ophir plantation. Section 4 presents the detailed results structured around our Institutional Analysis and Development framework iteration. In Section 5 the potential of farmer organisations to contribute to sustainable agricultural intensification and the usefulness of the framework are discussed. Section 6 provides the conclusion, in which the key lessons learned are presented.

2. Research approach

2.1. The combined IAD-SES-NAS framework

The framework used in this paper to structure findings and link actors, situations and context, is a combined IAD-SES-NAS framework developed by Ortiz-Riomalo et al. (2023b; see Fig. 1). This framework integrates the original Institutional Analysis and Development (IAD) framework with two of its extensions, the Social-Ecological Systems (SES) framework and the Network of Action Situation (NAS) framework (Cole et al., 2019; Ortiz-Riomalo et al., 2023a). All three frameworks originate from Ostrom's work on institutional analysis and have been extensively used to structure variables and relevant principles in collective action. However, although the IAD framework provides a clear feedback mechanism and focusses on dynamic processes, it has been criticised both for being too general and for its limited inclusion of ecological processes. In contrast, the SES framework is more complex, but lacks a dynamic 'working element' at its core (Cole et al., 2019; McGinnis, 2011; Ostrom, 2011). The NAS framework formalizes the influence of other relevant action situations, which was underdeveloped in the original IAD framework (Cole et al., 2019; McGinnis, 2011; Ortiz-Riomalo et al., 2023b). The resulting combined framework thus appears an appropriate holistic tool to structure and analyse how and why resilience of CA changed over a 40-year period, and its impacts on replanting and intensive smallholder FFB production in Ophir.

The left part of the framework identifies the pre-existing variables that are relevant to the case at hand. These variables are usually classified as either resources or resource systems (RS), resource units (RU), actors (A), or governance systems (GS), which can be further subdivided into fine detail, coded, and compared ((Cole et al., 2019; McGinnis, 2011; McGinnis and Ostrom, 2014) see Appendix 2 for an overview of codes). Pre-existing conditions subsequently enter the relevant network of action situations (see box A in the central part of Fig. 1), which is the core of the framework.

The action situation was defined by Ostrom (2005, 188; italics added) as there where "*Participants*, who can either be individuals or any of a wide diversity of organised entities, are assigned to *positions*. In these positions, they choose among actions in light of their *information*, the *control* they have over *action-outcome* linkages, and the *benefits and costs assigned* to actions and outcomes.". In our case, this is thus where

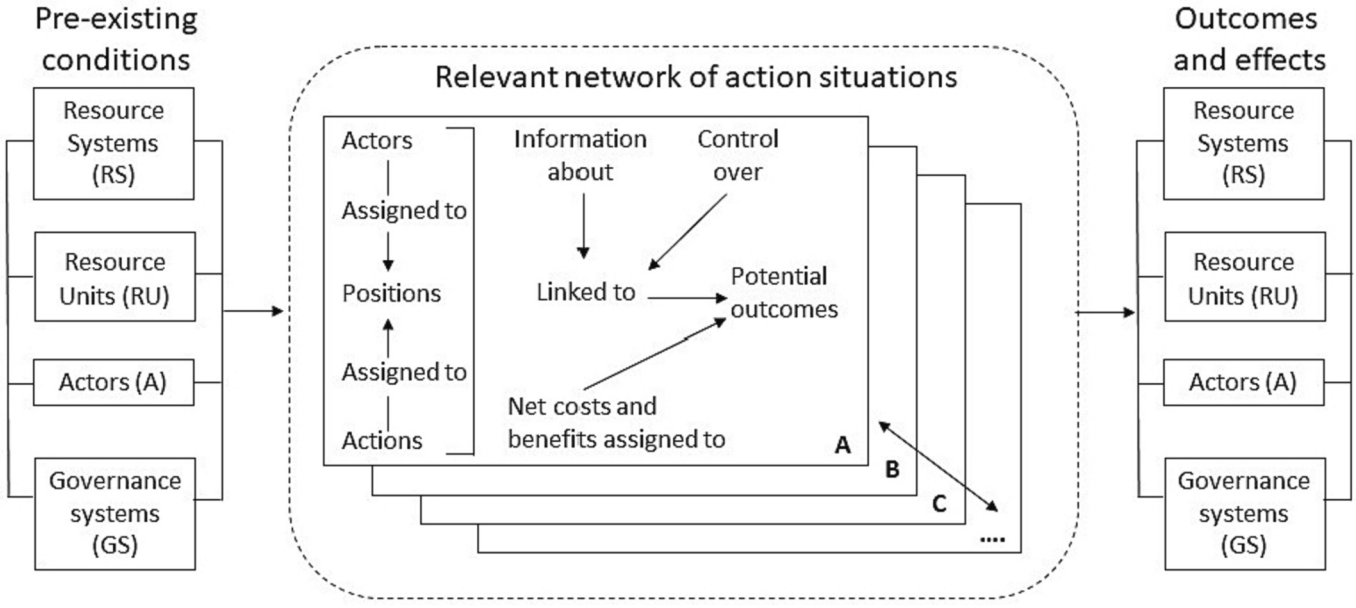

Fig. 1. The combined IAD, SES and NAS frameworks, after Ortiz-Riomalo et al. (2023b). Within box A we see the 'working element' in the focal action situation. A working element is also present in adjacent action situations (Box B, C, …).

participants, either individuals or groups, make choices on rules, and how or whether they will cooperate with one another in FOs. These rules can apply either at operational level (GS5), meaning day-to-day activities, or to collective choices (GS6), meaning making joint agreements, or constitutional choices (GS7), in which it is decided who makes the rules (Cole et al., 2019; McGinnis, 2011; Ostrom, 2011).

The network of action situations specifies two types of action situations. First, the focal action situation (see box A in Fig. 1) and second, the adjacent action situations (see boxes B and C in Fig. 1). Whereas the focal action situation is at the core of the analysis, it is influenced by both pre-existing conditions and adjacent action situations. The latter refers to related action situations that impact the focal action situation (Cole et al., 2019; McGinnis, 2011; Ortiz-Riomalo et al., 2023b). Thus, whereas choices made by farmers in a certain cooperative are the focal action situation for that cooperative, their choices also influenced the adjacent cooperatives and are therefore simultaneously adjacent action situations for other cooperatives.

A key theoretical assumption in many institutional analyses, including this one, is that many individuals are conditional co-operators. This implies that individuals will only cooperate when they believe others will do the same. As knowledge is often limited, trust is of critical importance (McGinnis, 2011; Ortiz-Riomalo et al., 2023a; Ostrom, 2011). Our study is thus rooted in political economy.

The choices participants make subsequently influence one or several variables, have effects and result in outcomes. These effects and outcomes become the pre-existing conditions for a new network of action situations. This feed forward mechanism allowed us to trace back relevant networks of action situations and to identify the points at which policy interventions may be most relevant (Cole et al., 2019; Ortiz-Riomalo et al., 2023a).

2.2. Methods

The first author of this paper undertook 11 field visits to Ophir plantation between 2009 and 2021 for various organisations and projects (see Appendix 3 for an overview of field visits and a list of recorded stakeholder interviews with reference numbers). The visits in 2009 involved four weeks of fieldwork in Ophir, when the primary aim was to

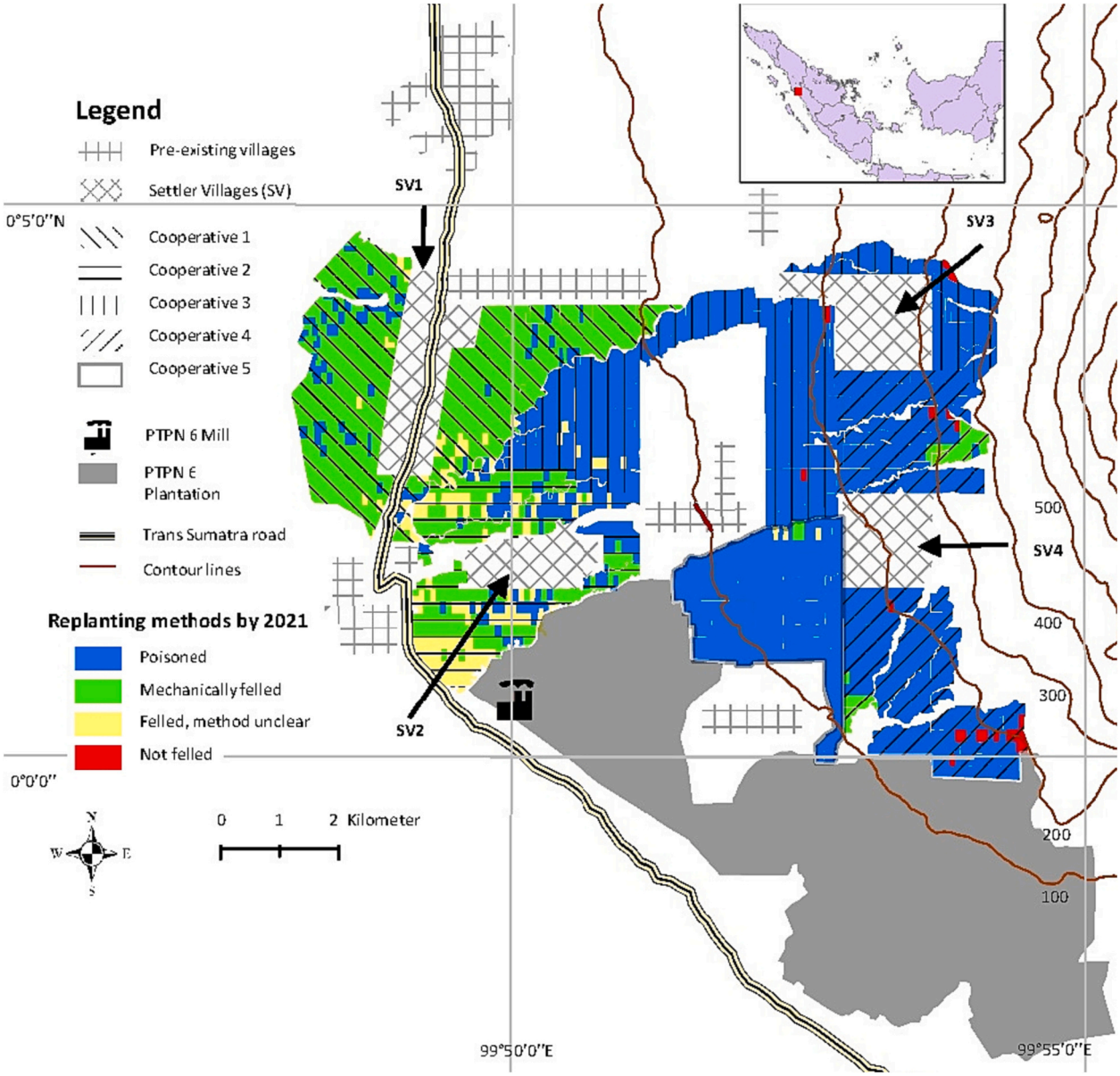

Fig. 2. Map of the Ophir plantation showing replanting strategies throughout Ophir up to 2021 (based on Google Earth and Airbus imagery).

understand how smallholders successfully managed their intensive production systems. The field visits in 2011, 2014, 2016 and 2018 each spanned 7–10 days and were undertaken for different projects. In 2020 and 2021, the first author undertook 42 days of fieldwork in Ophir for a project concerning smallholder replanting strategies. No predetermined research approach for this particular paper had been defined when data collection began. However, extensive fieldwork and repeated visits fostered closeness and trust among interviewees. This facilitated the collection of extensive qualitative and quantitative data which enabled us to perform a unique holistic analysis on why and how resilience of FO manifested itself differently across Ophir when farmers faced replanting.

Qualitative data were collected in semi-structured interviews, which provide focus whilst allowing the interviewer to follow up on information as it emerges (Magaldi and Berler, 2020). Key topics were the functioning of the FOs and CA and underlying reasons for differences between FOs, replanting costs and strategies. Reports were written on interviews conducted with farmers (21), farmer-group managers (25), cooperative managers (33), supra-cooperative managers (4), former GTZ project implementers (5), bank managers (4), nucleus-company managers (3), and labourers (4). Fully quoting exactly what each stakeholder said is limitedly possible as the interview reports mainly contained summaries of statements rather than literal transcriptions. Grey project literature was also collected, including reports written by project implementors and relevant institutions during establishment of the plantation. The large number of recorded interviews, and many more discussions that were not recorded, allowed us to triangulate our findings, which, in turn, provided relevant pointers towards critical action networks. Subsequently a well-informed narrative on developments in Ophir was constructed.

Quantitative data involved three components and substantiated the narrative provided by the qualitative data. First, data were collected from cooperatives on yields, production costs, deductions for services, and actual transfers associated with all 2400 smallholder plots in 2009. This allowed us to evaluate the economic performance of farmers and their organisations. Second, the quality of the planting material was checked by collecting fruits in 345 plots distributed across Ophir, opening one fruit from each of 20 different oil palms in each plot, and comparing the ratio of high oil yielding Tenera fruits to low oil yielding Dura fruits. Third, high resolution satellite imagery of the Ophir plantation acquired in 2014, 2016, 2018, and 2021, obtained from Google Earth and Airbus, allowed us to capture and quantify replanting strategies and progress (see Appendix 4 for classifications and illustrations of categories).

3. Origins of the NES Ophir plantation

The Ophir plantation (0° 1.66′N, 99°51.6′E) is located in the foothills of Mount Talamau, Pasaman Barat district, West Sumatra Province. After initial forest clearing in the 1920s and a corporate colonial oil palm plantation company that lasted until World War 2, the first oil palms were planted for smallholders in Ophir in 1982 as part of the Indonesian government-led and international donor-financed Nucleus Estate Smallholder (NES) programme (KfW, 1981; Rosenquist and Anderson, 1975).

The NES programme kicked off the development of smallholder oil palm in Indonesia in the late 1970s and was primarily sponsored by the World Bank. The Indonesian NES-programme was based on FELDA schemes in Malaysia that had emerged in the 1950s, which themselves were largely a product of colonial era thinking on efficient plantation agriculture, as donor experts had often previously worked for colonial institutes (Robins, 2021; Sutton, 1989). In NES schemes, mutual dependencies between plantation companies and smallholders were created, in which farmers provided produce for the nucleus company, and the nucleus company provided modern inputs and a market for the smallholders. NES projects were intended to serve as a driver of local development, reduce the migration of rural populations to cities, improve rural incomes, counter swidden agriculture, improve export earnings for Indonesia, and make use of the huge potential of Indonesia's outer islands (Badrun, 2011; Robins, 2021; World Bank, 1989). By having efficient smallholder production systems, farmers were expected to obtain fair incomes, much in line with current sustainability narratives. However, NES projects also frequently involved land conflicts, antagonistic interests between companies and farmers, paternalistic company approaches that disregarded smallholder needs, smallholder dependency, and lack of finance and human resources with various implementing stakeholders. This caused many smallholders to abandon their projects, particularly in the early years (BMZ, 1992; McCarthy, 2010; World Bank, 1989). Furthermore, projects were often associated with unequal distribution of benefits between locals and migrants (Cahyadi and Waibel, 2016; McCarthy, 2010; Robins, 2021).

In Ophir, PTPN-6 was the state-owned plantation company that served as the nucleus and was responsible for developing its own estate (3163 ha) as well as the smallholder plantations (4800 ha). The company was responsible for the purchase and planting of quality planting material, the development of infrastructure, the construction of houses for settlers, training the smallholders, the purchase and processing of FFB, and the collection of payments owed by the smallholders for plantation and housing establishment, which was set at 30% of gross yields (BMZ, 1986, 1992). Uniquely, German donors financed this project and provided technical assistance with the explicit goal of establishing strong independent smallholder organisations to counter the frequently observed smallholder dependency on poorly performing state-owned plantation companies (BMZ, 1992; KfW, 1981; World Bank, 1989).

4. Results

The 40 years of smallholder oil palm developments in Ophir can be divided into three shorter time frames, with each period covering a network of action situations (see Fig. 3). As the outcomes and effects form the pre-existing conditions for the following network of action situations, we only present the pre-existing conditions and action situations per period. In the first period we explicitly unpack all relevant starting conditions. In the subsequent periods we only mention variables deemed to be the most relevant for the following network of focal action situations. In the final period, ending in 2021, we also evaluate the outcomes of the replanting strategies.

4.1. Plantation establishment (1981–1994); setting up farmer organisations

This first period lasts from 1981, when the first planting commenced and first farmers were assigned plots, to 1994, just after the withdrawal of significant external support by GTZ.

4.1.1. Resource system

All 2400 farmers in Ophir received a 2-ha plot with oil palms, a settler house and home plot (RS1). Whereas the boundaries of cooperatives shifted slightly during this period as some FGs were incorporated into a neighbouring cooperative (RS2 and RS3), the boundary of the whole Ophir plantation did not change. The first plantings took place in the western parts of the plantation and subsequently shifted eastwards. Cooperative 1 was established first, followed by Cooperative 2, 3, 5, and lastly Cooperative 4 (see Table 1). Cooperative 5 was initially part of the PTPN-6 plantation but was transferred to smallholders to compensate for areas that could not be developed for the smallholders (interviews 89–91;(BMZ, 1992; Heering, 1993)).

The geographic conditions (RS9) vary considerably depending on the cooperative. The western part of the plantation, where Cooperatives 1 and 2 are located, are relatively flat. The eastern sections, where Cooperative 4 is located, are hilly. Cooperative 5 is in an intermediate but uniform position, whereas Cooperative 3 includes both flat and hilly

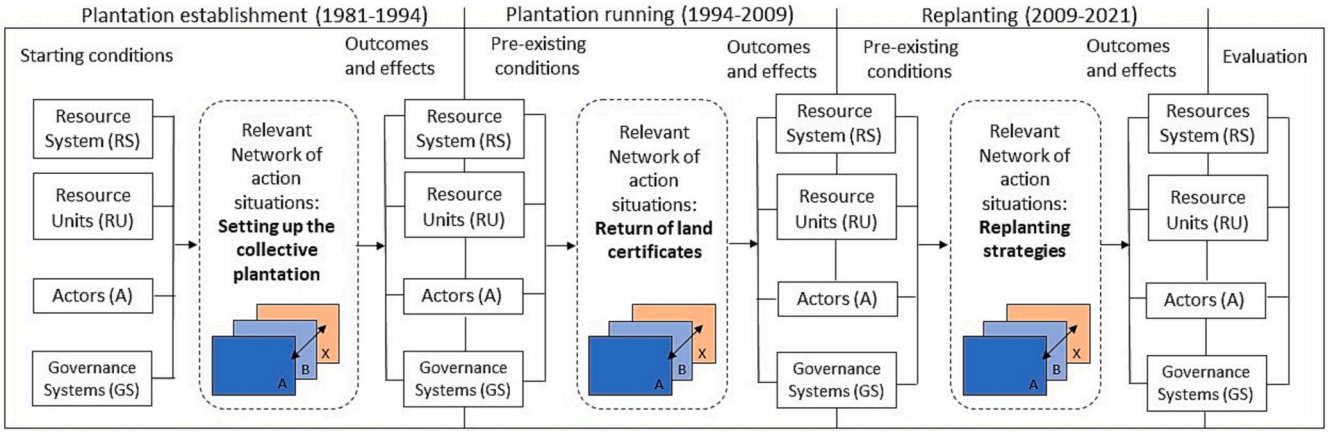

Fig. 3. Framework applied to the Ophir case. A = focal action situation in a given cooperative, B = adjacent action situation in other cooperatives, X = other relevant adjacent action situations.

sections (see Fig. 2). Soils in the western part largely consist of fine volcanic ashes whilst in the eastern part, soils are much coarser and contain many boulders, which limit yield potential (RS5). The eastern part is dissected by many streams, has more cloud cover and rainfall reached 5000 mm year^{-1}, compared to 3400 mm year^{-1} in the western part. The characteristics of the resource system (RS9) led to higher road and bridge maintenance, less photosynthesis, and a larger loss of fertiliser due to leaching in the eastern parts of the plantation. Consequently, costs in the eastern sections were higher, but yield potential was lower (Hieman, 1990a; Rosenquist and Anderson, 1975; Uexküll, 1988).

4.1.2. Resource units

The age of the oil palms and hence the stage of maturity (RU7), was generally similar in each cooperative, but differed significantly in Cooperative 3, where the first plantings took place in 1983 in its western and most suitable areas, and where the last plantings took place in the eastern sections in 1986 (see Table 1). This lack of a uniform mature stage everywhere resulted in varied yields and hence more complex and costly management practices at cooperative level (Fairhurst et al., 2019) and, in addition, reduced cohesion within the cooperative (Hieman, 1990a). Meanwhile, in Cooperative 4, some sections were poorly developed by PTPN-6 and required considerable replanting (BMZ, 1992). This not only caused diversity in planting age, but also animosity between farmers and as a consequence, reduced solidarity between farmers (A6) (interview 53). However, although there were significant differences between cooperatives, by 1994 the FFB yields and associated economic value (RU4) were good and a high input / high output production system had been successfully established throughout Ophir (see Table 1).

4.1.3. Actors

The farmer population in Ophir during establishment was diverse in terms of occupation, origin and past history (A3). On average, Javanese comprised 35% of the Ophir population, Batak 15%, and Minang, the indigenous ethnic group in West Sumatra, 50%. These ethnicities were associated with different characteristics; Javanese were deemed diligent workers looking for harmony, Bataks were associated with directness and pushing for decision making when necessary, whilst Minang were associated with business acumen (interviews 17, 31, 75, 89–91, (GTZ, 1995)). Whereas 50% of the farmers were local, the other half were migrants, often former civil servants or military personnel (GTZ, 1995). Ex-military personnel and civil servants were considered more experienced in working in modern, hierarchical organisations, which proved a valuable asset for establishing operational FOs (interviews 89–91,(GTZ, 1995). In line with findings reported by Krishna et al. (2017) in neighbouring Jambi province, locals in Ophir generally also owned other plots of land, were involved in other activities, were less focused on oil palm, and generally participated less in training on CA and oil palm cultivation (interview 17, 31, 38, 75, 89–91). Table 1 illustrates the significant differences in the backgrounds of the farmers in each cooperative in Ophir.

During the establishment of Cooperatives 1 and 2 there was limited clarity about profitability of smallholder oil palm, and smallholders

Table 1
Overview of Ophir plantation characteristics in its initial stages (sources; GTZ (1995); Hieman (1990a); original cooperative member lists/archives). Cooperatives 4 and 5 were still repaying their credits in 1994. In the 1990s, two FGs that originally belonged to Cooperative 2 joined Cooperative 1 because they were located on the same side of the river as Cooperative 1. FGs 63–67 were initially part of Cooperative 4 but soon after establishment joined Cooperative 3, which explains differences in the number of members in 1994 vs. 2009.

Cooperative	No. of farmer-groups in 1994 (in 2009)	No. of farmers in 1994 (in 2009)	Total area in ha in 1994 (in 2009)	Year of planting	Mean gross farmer income in 1994 (in US $)	Mean payments for plantation management farmer^{-1} in 1994 (in US$)	Mean net farmer income in 1994 (in US$)	Repay-ment period	% ethnicity (Minang/ Javanese/ Batak)	% occupation (military/ civil servant/ general population)
1	24 (26)	550 (591)	1100 (1182)	1982	5214	1009	4205	1987–1991	42/40/18	37/0/63
2	17 (15)	375 (334)	750 (668)	1982–1983	4815	1009	3806	1988–1992	31/55/9	57/0/43
3	21 (26)	500 (629)	1000 (1258)	1983–1986	4628	846	3449	1989–1994	64/23/12	15/12/73
4	28 (23)	669 (540)	1328 (1080)	1986	3904	796	1942	1992–1997	50/36/12	49/12/39
5	12 (12)	306 (306)	612 (612)	1984	4676	856	2763	1990–1995	71/15/14	0/45/55

were hesitant to go into debt (interviews 75, 84, 89–91;). Initially GTZ project implementers led participant selection and arguably selected those they believed would increase the likelihood of achieving functioning organisations (Bauer, 1991; Bergschneider, 1990). These first farmers initially suffered from low FFB prices and went through hardship together, which created a bond between them (A3) (interviews 54, 75, 89–91). In the second half of the 1980s, however, palm oil prices surged, and it became clear that the projects were highly profitable (Bergschneider, 1990; Hieman, 1990b). As stated by a former village head and leader of Cooperative 3 (interview 64), the situation changed 'From plantations looking for farmers, to farmers looking for plantations.". During the establishment of Cooperative 3, the GTZ project facilitator was accused of communism due to his focus on strong farmer organisations, which was a serious accusation in New Order Indonesia (interviews 89–92). Although he received support from project implementers and was able to continue his work, the accusation resulted in the selection procedure being taken away from GTZ project implementers and becoming much more political (interviews 89–92). Subsequently a higher proportion of poor local participants entered the project, as well as elites (A2) (interviews 50, 64, 89–92).

Initially, members often lived together in settler villages (A4), shared a social network, and capitalised on the advantages of close monitoring associated with smallholders (Bizikova et al., 2020; Hazell et al., 2010). They could thus easily monitor whether rules concerning rights and responsibilities were being respected (see following section; Appendix 1). Farmers who were members of Cooperative 1 and 2 were almost exclusively residents of Settler Villages 1 and 2, respectively, which were located near the Trans-Sumatra Road linking them to commercial activities and public services. Farmers in Cooperative 3 were spread out in Settler Villages 2 and 3, and were therefore much farther apart, which limited interactions and the building of trust between farmers. Farmers in Cooperatives 4 and 5 were allocated houses in Settler Villages 3 and 4. These villages were located in the most eastern sections of the plantation, in quite remote places, and were initially not even connected to the electricity grid (GTZ, 1995).

4.1.4. Governance systems

In the Ophir NES-PIR project, the Indonesian Government (GS1) collaborated with German development organisations (GS2). Government involvement consisted of PTPN-6 establishing the plantation, but also a Provincial Coordination Committee (PCC) to coordinate government institutions, monitor progress in, for example, the construction of settler villages, roads, establishing schools in the settler villages, setting up a banking system and mediating conflicts between PTPN-6, farmers and government organisations. At its peak around 1990, the Ministry of Agriculture Extension Service had a staff of 28 (interviews 52, 89–92, (Bauer, 1991; BMZ, 1992)).

From 1982 to 1993, German technical support focussed on institutional development of farmer organisations (BMZ, 1992; GTZ, 1995; Heering, 1993). The institutional setup of the smallholder organisation (GS3) began with the development of FGs and was characterised by private ownership combined with collective management. Farmers had shared incomes at farm-group level, leading to income dependency based on group performance. This stimulated smallholder monitoring and the correction of performance by fellow group members. If farmers did not maintain their fields correctly, the group leader insisted on high standards, and money was deduced from the income received by non-compliant farmers to pay for plantation maintenance. Cooperatives were responsible for activities that were better organised at scale, such as procuring fertiliser, maintaining a technical unit for pest and disease management, leaf analysis, road maintenance, and other forms of support for smallholders. The supra-cooperative was set up once all FGs and cooperatives were established and was subsequently responsible for services that were better organised at a higher level, such as negotiations with PTPN-6 or other stakeholders. Training was provided to institutionalise the rights and responsibilities of farmers and their management as an integral part of the project (GS5, GS6 and GS7), by ensuring transparency, e.g. through computerised payment systems and printed monthly overviews of costs and deductions, and focussing on democratic decision making (Bauer, 1991; Heering, 1993; Jahn et al., 1999).

Between 1982 and 1993 GTZ spent an average of approximately US $2150 per farmer on the institutional set-up (BMZ, 1992; Jahn et al., 1999), corresponding to roughly half a year's nett income in Cooperative 1 in 1994 (see Table 1). However, farmers in Cooperative 1 and 2 received external support and were subject to monitoring much longer than farmers in the eastern parts of the plantation (see Table 1), which limited monitoring and evaluation of commitment to rules and regulations in the eastern sections (A3, A6) (interview 54).

4.1.5. The network of focal action situations: commitment to the institutional set-up

The above-mentioned pre-existing conditions revealed significant differences in the farmers' backgrounds and in conditions between the cooperatives. Farmers in Cooperative 1 and 2 generally lived in each other's vicinity (RS9) and their homesteads were closest to public services and to their plantations (RS9), which significantly improved monitoring, trust, and reciprocity between farmers (A6). Furthermore, these farmers had the highest yield potential (RU4 OR RS5), had received most training and support (GS1 and GS2 support) and farmer selection had been geared towards project success (A2, A3).

Farmers in Cooperative 3 had less favourable previous histories, backgrounds, and socio-economic attributes (A2 and A3). These farmers were also spread out over two villages (A4), and the plots belonging to the farmers in this cooperative had significantly diverse yield potentials (RS9) as well as being at different stages of maturity. This resulted in diverse yields (RU5) and incomes (RU4), and consequently different assessments of the costs and profits from their plantations and hence more challenging conditions for management to deliver services that fit all farmers' interests.

Conditions in Cooperative 4 and 5 were different again. These farmers received much less external support and institution building (GS1, GS2), and lived in more remote areas (A4). Subsequently, this led to a relatively high proportion of farmers immediately moving out of the remote settler villages, leading to absenteeism, limited trust between members and less solidarity (A6) (Bergschneider, 1990; Hieman, 1990a; Jahn et al., 1999). Cooperative 4 also suffered from poor plantation establishment in certain sections of their plantation (RS5, RU4), resulting in animosity and reduced solidarity between farmers there (A6) (interview 54, 25, 89).

Nevertheless, at this stage all the farmers in Ophir adhered to the constitutional rules (GS7) and collective choice rules (GS6) set down by the NES/PIR programme, PCC-GTZ institutional guidance and negotiations with, and between, farmers and their organisations. As external input suppliers and alternative markets for FFB were either absent, or extremely complicated during this period, farmers feared being expelled from existing structures (interviews 89–92). Furthermore, farmers were tied to the established structures until they had repaid the establishment costs of the project (GS4), (BMZ, 1992; GTZ, 1995; Hieman, 1990b). The differences in the variables mentioned in the previous section influenced farmer assessments of cost-benefit analysis, and their positions towards "*togetherness*", a term used by Ophir participants to describe solidarity and a tendency towards collective action (interviews 10, 48–53, 61, 74, 75, 82).

4.2. Plantation up and running (1994–2009)

4.2.1. Pre-existing conditions for the new NFAS

In 1993, the extensive external support provided by the PCC (GS1) and GTZ (GS2) ended, and farmers and their organisations were basically left to their own devices. The institutional set-up was similar throughout Ophir, with PTPN-6 purchasing the FFB. However, conditions for trust were clearly most favourable in Cooperatives 1 and 2,

whereas the other cooperatives suffered more hardships (see previous section).

By 1994, the average farmer incomes (RU4) and FFB production (RU5) in each cooperative were good and the smallholder plantation served as a driver of local development. These developments meant the establishment debts at PTPN-6 were quickly paid off (Table 1). The land certificates were subsequently transferred from PTPN-6 to the cooperatives. Farmers throughout Ophir invested in their children's education, purchased consumer goods, became interesting clients for banks and other credit suppliers and seized other investment opportunities (GTZ, 1995; Hieman, 1990b; Jahn et al., 1999); all these were adjacent action situations that influenced farmers' choices concerning CA.

4.2.2. *The network of action situations: choices concerning the position of land certificates and replanting funds*

In the second half of the 1990s, farmers in Cooperative 3 demanded that their land certificates be transferred to the individual farmers (interviews, 37, 58, 40, 56, 54, 106). These farmers wanted to use the land certificates as collateral at institutions that provided higher loans than those offered by their own FOs, and there was a strong sense that individual farmers had earned their land titles. It also suggests that from early on, the farmers did not fully trust their management with these important documents (see Section 4.1). Although the supra-cooperative advised against it (interview 54), Cooperative 3 management agreed to transfer land certificates.

The events in Cooperative 3 led to similar discussions in the other cooperatives, and to the transfer of land certificates in Cooperatives 2, 4 and 5. However, although tense discussions took place in Cooperative 1, the cooperative management there convinced its members that it was better for their "togetherness" to maintain certificates at cooperative level (interviews 88, 40, 53, 54), highlighting more trust in the cooperative leadership (A5) and in their FO. Besides the return of land certificates, farmers in cooperatives 2, 3, 4 and 5 also demanded that their replanting funds be partially paid out in times of low prices when farmers suffered from financial hardship (interviews 40, 41, 54, 88). As various FO leaders pointed out, farmers in cooperatives 2, 3, 4 and 5 in particular, chose leaders who promised them the most income in the short term. Also, many of these FO leaders were involved in politics and in business and were easily associated with abuse of funds (interviews 36a, 38, 39, 63, 80, 84).

An important adjacent action situation that emerged during this period was the transformation of West Pasaman into a fully developed oil palm landscape. From no oil palms in 1980, by 2009, 39.1% of West Pasaman's 388,800 ha were under oil palm, with 58.9% of the oil palm area belonging to smallholders (DJP, 2010). Alternative mills emerged and agro-inputs became readily available. This meant that, in contrast to the previous period, that farmers now had the opportunity to act outside the Ophir institutional setup. Nevertheless, all 2400 oil palm plots (RS2, RS3) remained under the management of farmer organisations (GS5, GS6). This meant that although operational rules and collective choices within Ophir now differed on some points, constitutional rules (GS7) remained intact and farmers generally judged their FOs and CA favourably.

4.3. *Plantations at the end of their economic life span (2009–2021)*

4.3.1. *Pre-existing conditions before replanting*

Before the next action situation, there was a 15-year period during which both farmers and their oil palms aged. Available data concerning management[1] in Cooperatives 1, 2, 4, and 5 indicate that between 1991 and 2009 most changes in land ownership occurred due to inheritance. Land sales accounted for only 11.6% ($N = 311$), 37.2% ($N = 258$), 22.2% ($N = 54$), and 0% ($N = 13$) of changes in registered land ownership in Cooperatives 1, 2, 4, and 5, respectively. However, the transfer of land certificates to individual famers reduced oversight at cooperatives on who their members were as unregistered sales occurred (Jahn et al., 1999), as members did not always report changes in landownership as fees had to be paid for this (interviews 58, 59, 84). This may partially explain limited registered landownership transfers in especially Cooperatives 4 and 5.

Farmers aged and many opted to spend their retirement closer to their roots or at locations with better medical facilities, thus increasing absenteeism. As Settler Villages 3 and 4 were the farthest away from services (see Fig. 2), absenteeism increased most among farmers in Cooperatives 4 and 5 (interviews 36a-47). A 2009 survey showed the average age of the farmers was 53 (SD = 14.0) in Ophir, and that 68.5% of the farmers still belonged to the first generation of smallholders (Jelsma et al., 2009). While FOs managed farm inputs, labour, and marketing (GS6, GS7), it is noteworthy that the quality of these services, the operational rules (GS5), varied significantly between Cooperatives and FGs, with monitoring frequently lacking in the most remote areas (interviews 5, 20, 36a, 43, 77).

Although yields had been good throughout Ophir during the first oil palm cycle (see Table 2), by 2009, yields and oil content were decreasing significantly due to ageing of the palms (RS5; RU4, RU5). PTPN-6 subsequently reduced prices and replanting became increasingly important (interviews 1, 2, 3, 9, 29, 48–53, 105). However, many farmers had taken large loans from their cooperatives, FGs, and banks, which were automatically repaid with the proceeds from their oil palm. Many of the activities of the FOs in Ophir were co-financed with the interest gained from internal loans. However, due to reduced yields, many farmers no longer received sufficient income to pay off their debts, or their debts were even increasing rather than decreasing (see Table 2; whisker and box plots in Fig. 4).

Strategic default became a relevant choice for some farmers as agro-inputs and markets for produce were available for individual farmers, and managers in Cooperatives 2–5 did not always have the land certificates as collatoral (see Section 4.2). As non-performing loans were ultimately paid for by diligent FO members, smallholders particularly in Cooperatives 2, 3, 4 and 5 were disappointed. These farmers frequently associated bad lending practices with lack of transparency and nepotistic behaviour by FO managers, which eroded trust in management (interviews 14, 16, 17, 21, 40, 36b, 37). By then, most FO managers were desperately trying to keep farmers in their organisations, in contrast to at the start of the project (interviews 48, 53).

In 2009, significant differences in performance were obvious in Ophir (see Table 2 and Fig. 4). Whereas the oil palms in Cooperative 1 were the oldest and could thus be expected to have the lowest yield, gross income (F value = 323.804; $P = .000$) and final payments (118.475; P = .000) were significantly higher in Cooperative 1 than in the other cooperatives (Fig. 4 and Table 2).

As the natural conditions were similar in Cooperatives 1 and 2, Fig. 4 and Table 2 reveal that operational rules (GS5) were applied quite differently in the two cooperatives. By 2009, Cooperative 2 had much lower yields, much higher cooperative deductions and much lower final payments than Cooperative 1. These excessive deductions were intended to recapitalize replanting funds and cover bad loans. However, the high deductions left many farmers with insufficient income and reduced trust in the ability of the management to collectively organise replanting, both influencing their valuation of CA.

Fig. 4 also illustrates the importance of geographic differences within Ophir. For example, the oil palms in the western section of Cooperative 3 (FG 43–52) were planted were planted earlier, but their conditions were relatively favourable like those in Cooperative 1. Oil palms in the less favourable eastern sections of Cooperative 3 (FG 63–67) were planted later, but delivered much lower yields and incomes. When the wife of a first-generation farmer in FG 67, was shown yields and incomes in

[1] Cooperatives 1, 4, and 5 provided member lists. Similar lists could not be obtained for Cooperatives 2 and 3, but the last Cooperative 2 leader provided insights based on memory.

Table 2
Overview of average expenditures and incomes at the cooperative level per month from February to May 2009 (Source: cooperatives).

Cooperative	Average yield for years of production (tons per year)	Years of production	Average gross monthly income per farmer in 2009 (in US$)	Average deductions farmer^{-1} month^{-1} by cooperative management		Average income farmer^{-1} month^{-1} after payments for services at cooperative level in US$	Average actual transfer to farmer per month after repaying loans	
				In US$	As share of gross income		In US$	As share of gross income
1	27.4	25	693	115	16.6%	579	376	54.1%
2	24.8	24	539	187	34.9%	352	157	28.9%
3	22.4	19–23	479	103	21.9%	377	207	42.1%
4	22.5	19	450	124	27.7%	327	155	34.0%
5	24.9	24	539	139	26.0%	399	176	32.5%

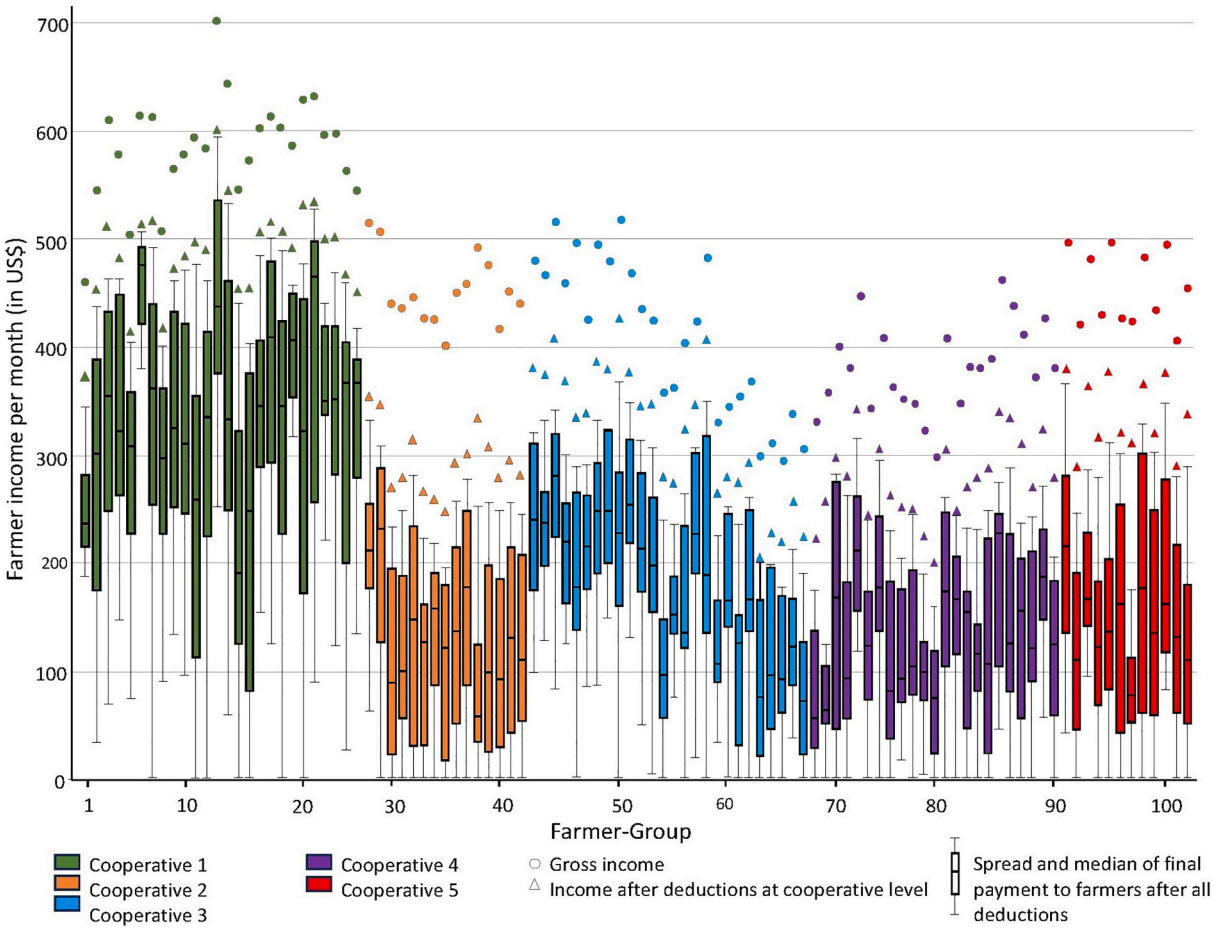

Fig. 4. Monthly oil palm incomes and deductions among FGs in 2009. The whisker and boxplots show actual transfers to farmers in each FG (the box shows the 1st and 3rd quartiles; the horizontal line in the boxes represents the median transfer. Final transfer to a smallholder is the gross income (o) minus deductions for cooperative plantation management services and compulsory savings (Δ) minus individual debt repayments at the level of the FG, cooperative, supra-cooperative accounts, cooperative shop and banks (source: cooperative managements).

Cooperative 1, she explained that their incomes had never been anywhere close. They had always struggled and asked their FOs for loans to cover their needs (interview 39). As yields in the western region of Cooperative 3 constantly lagged behind those of Cooperative 1, this discrepancy can be attributed to better management and better practices in the latter (A5, A6, GS5, GS6). However, in Cooperative 3, the western section obtained considerably higher yields than its eastern counterparts, despite comparable cooperative support. Such differences accumulated over a 25-year period, thereby shaping the farmers' short-term and long-term choices.

4.3.2. The network of action situations: renegotiating Ophir institutions and replanting

Changes in the constitutional rules (GS7) in the Ophir FOs commenced on the 28th of April 2009, during the annual meeting of Cooperative 3. During this event, various group leaders and members indicated they intended to leave the Ophir structure as they no longer had any confidence in the cooperative. Indeed, there were almost no replanting funds available and although replanting strategies were requested, they were not provided (interviews 10, 17, 20, 38, 56, 62, 84).

All cooperative managements were looking for external assistance, but government and PTPN-6 support policies proved to be unsuitable (GS1) as they required land certificates as collateral, and these were mostly incomplete at cooperative level. Furthermore, government policy at that time required farmers to replant like best practices with companies. This meant no intercropping and consequently no income for three years, which was unacceptable for most farmers (interviews 10, 70, 81, 84). Farmers in Cooperative 3 increasingly left, started side selling FFB, or sold their plots. Newcomers were generally not interested in joining the FOs which by then, were mostly dysfunctional, and eventually it became increasingly unclear who were still members of the cooperative and who were not (interviews 34, 36a, 36b, 62, 73, 84). By 2012, the remaining funds were distributed to farmers for replanting at FG or individual level, and Cooperative 3 no longer provided services (interviews 79, 84).

In contrast, in Cooperative 1, all land certificates were present, and over the years, the management had collected replanting funds from farmers worth US$2000 per person (interviews 67, 70, 72, 77). This allowed the cooperative management to propose an advanced replanting strategy to its members in 2012. The strategy comprised the purchase and transport of high-quality planting material; the creation of nurseries; mechanical felling and chipping; a monthly allowance of US $77 for 24 months during the immature stage of the plantation; the planting of palms and application of fertiliser during the immature period; support from the cooperative's technical unit; and a bank loan. The costs of this program were US$6692 for 2 ha, of which 70% was spent on financial services and management. These services included a 3-year grace period, a guaranteed maximum of 30% of gross FFB sales deductions for credit repayment, and an insurance that waived debts in the case of death of the farmer. Cooperative 1 was able to maintain a strong membership base, with only 84 out of 591 members opting to leave cooperative guidance (interviews 13, 15, 18, 29, 32, 60, 67). These findings are in line with the satellite imagery data presented in Fig. 2.

In 2012, Cooperative 2 management also presented a collective replanting strategy, in which 148 of the initial 336 plots participated (interviews 61, 69; 78; see Fig. 2). However, financial reserves were limited, as was farmers' confidence in the plan and in management. Participating farmers handed over their land certificates to the cooperative, which used them as collateral for replanting (interviews 14, 21, 23, 61, 78). Whereas the contractor had already started mechanical felling, the bank loan did not come through as government lending policies became stricter, the previous performance of the cooperative was sub-optimal and many land certificates were missing (interviews 69, 78, 84, 85, 86, 88). Collective replanting stopped and participating farmers were left owing US$900 to the cooperative for the mechanical felling of palms, which had to be repaid before the farmers could reclaim their land certificates. This failure sent a clear message to farmers throughout Ophir about the risks of CA and effectively ended CA among farmers in Cooperative 2. FGs were also mostly dissolved, their assets were sold, and remaining funds were distributed to farmers who replanted either in smaller groups or individually (interviews 12, 21, 23, 33, 34, 61, 78, 79).

Whereas richer farmers could afford to replant on their own and left the organisation earlier, many other farmers delayed replanting as they could not afford three years with no income (A8). Many farmers sold their planation once FOs collapsed as incomes had been poor for years, considerable investments were needed, and they were bitter over mismanagement and CA (interviews 14, 23, 21, 33, 34, 35, 61, 64, 78, 84). In Cooperatives 4 and 5, replanting was due later (see Table 1). However, these cooperative managements could not provide a complex replanting strategy like that provided by Cooperative 1 for reasons similar to those in Cooperatives 2 and 3. Furthermore, the negative experience in Cooperative 2 reduced the farmers' confidence in collective strategies, illustrating the relevance of adjacent action situations.

According to the lists provided by the management of Cooperatives 4 and 5, respectively 22.6% and 45.4% of the members officially terminated their membership just before or during replanting. Although additional replanting funds were available at the FG level, cooperative replanting funds ranged from US$385 to US$615 per farmer. The management of Cooperatives 4 and 5 provided relatively simple services to members such as collective purchase of high-quality planting material, running a nursery, transporting seedlings, and facilitating the poisoning of old palms (interviews 41, 43, 58, 75, 76, 80, 81, 84). Expenditures for such strategies were limited to approximately US$835 per plot. However, under this strategy, dead palms decompose while standing and eventually fall, potentially damaging young oil palms and other crops, and increasing the risks of carryover of pests and diseases due to poor plantation hygiene (Beaudoin-Ollivier et al., 2017; Fairhurst et al., 2019; PalmElit - CIRAD Inside, 2018).

4.3.3. Outcomes: implementation of replanting strategies (2013–2021)

Fig. 2 gives an overview of the different replanting methods based on satellite imagery to illustrate how the plantation was influenced by the partial disintegration of the Ophir institutional set up (GS5, GS6, GS7). Mechanical felling, the method most associated with Good Agricultural Practices, predominated in Cooperative 1, was partially used in Cooperative 2, and by only two FGs in Cooperative 4. Even though these FGs proved that mechanical felling can still be organised at FG level with limited advantages of scale, this was not popular due to the high cost compared to poisoning and the amount of organisation it required (interviews 40, 41, 44, 76, 80). One of the FGs involved also collapsed during replanting due to lack of transparency with funds (interviews 25, 80).

By 2021, canopy uniformity in Cooperative 1 stood out as 94.3% of the plots were covered with second-generation oil palms featuring closed canopies (see Fig. 5 and Appendix 5). In contrast, Cooperative 2 lagged far behind, with only 37.1% of plots exhibiting similar progress, highlighting significant replanting challenges and production delays. Interestingly, individually managed plots in Cooperative 1 closely resembled conditions seen in Cooperative 2 (see Appendix 5). In 2021, in former Cooperative 4, 84.2% of the palms were in their second cycle, either very young or maturing stage (see Fig. 5 and Appendix 5). This high level of uniformity surpasses that of former Cooperatives 3 (51.5%) and 5 (53.6%), potentially facilitating renewed CA in Cooperative 4 as more farmers share similar oil palm conditions.

During replanting, maize intercropping was massively taken up by farmers throughout Ophir to generate income during the immature period when oil palms were not producing (personal observations by the first author; interviews 29, 66, 67, 76, 79, 80, 81). The managements of Cooperatives 1 and 4 intercropped the young oil palms with maize and marketed the grain for its members. Although some farmers grew maize themselves and marketed it via the cooperative or individually, others rented out their land for maize cultivation, mostly to entrepreneurial Ophir farmers or locals who lived nearby (interviews 66, 67, 76, 79, 80, 81). During these years several former group leaders and farmers became middlemen, who could challenge the reestablishment of initial FOs once oil palm in Ophir becomes productive again. Most farmers purchased planting material that yields Tenera fruits (see Appendix 5), indicating farmers acknowledged the importance of proper planting material and had access to it, most likely via PTPN-6.

4.4. Evaluation: Post 2021

By 2021, a striking 97.8% of the 2400 plots in Ophir had been replanted (Fig. 5), demonstrating the resilience of oil palm itself (RS1). However, the resilience of FOs (GS5, GS6, GS7) proved to be less uniform.

Cooperative 1 continues to provide extensive services to 85.8% of its original 591 plots and also continues to obtain exceptional yields in its second cycle (Table 3). Cooperative 1 actively engages in pest and disease management, road maintenance, and formed a strategic partnership with a leading private sector company that offered technical

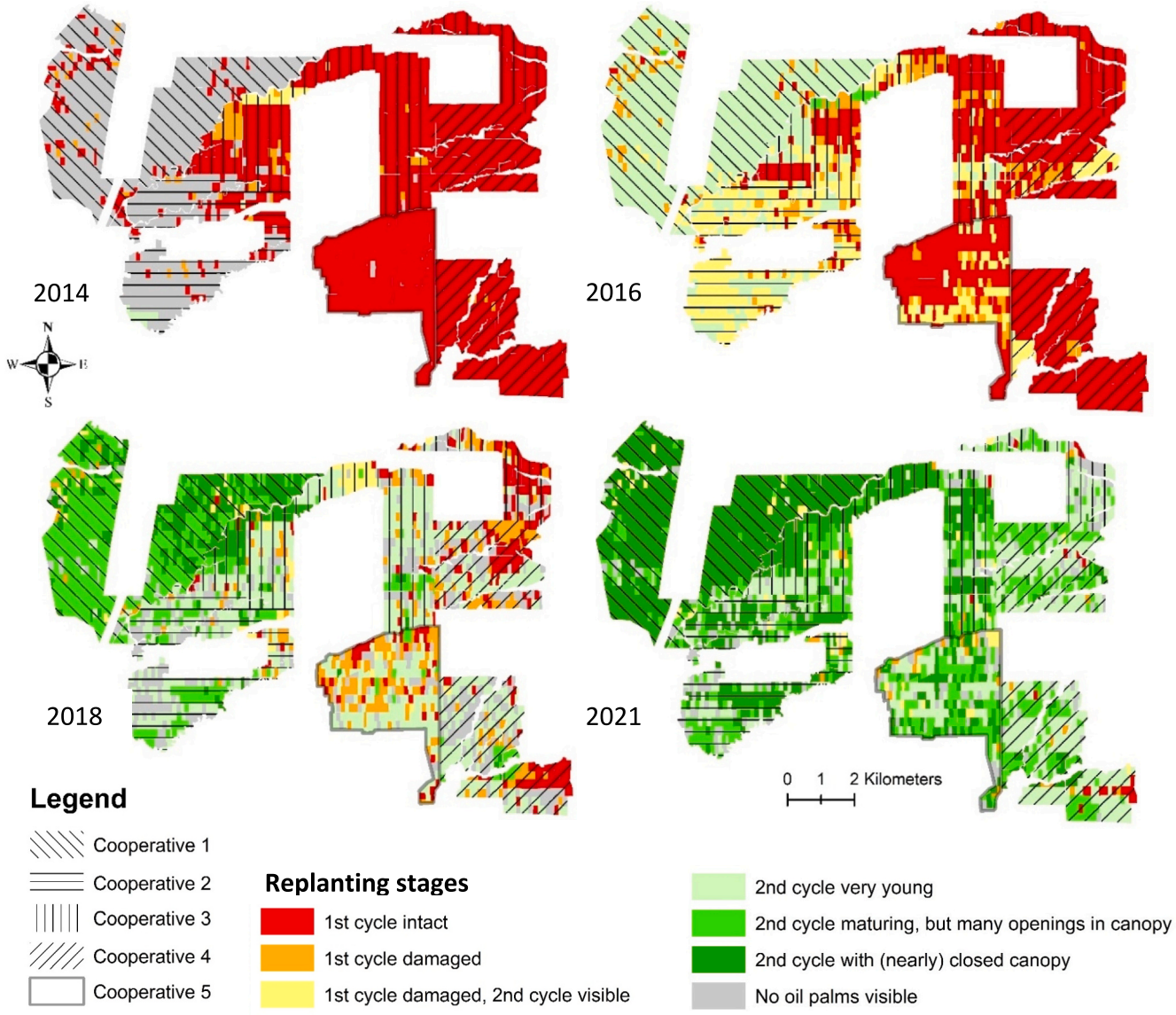

Fig. 5. Replanting progress in Ophir from 2014 to 2021 (Source: satellite imagery).

Table 3
Overview of the performance of some farmer organisations in 2021 (all currencies in US$; exchange rate 1 US$ = 14,296 IDR). Data on independent smallholders were not available because many do not systematically maintain records.

Organisation	Year of planting	Propor-tion of original plots	Yields in ton^{-1} year^{-1} ha^{-1} (first-cycle yields, similar oil-palm age)	Average price per ton (2021)	Expen-diture for fertiliser in 2021 (in US$)	Compiled deductions (in US$)	Final net payment in 2021 (in US$, excluding credit repayment)	Replanting credit repayment in 2021 (in US$)
Cooperative 1 members	2014	85.8%	31.9 (27.7)	159.2	618.5	1343.2	3594.9	1350.1
Farmer-group 51 (Coop 3)	2013	62.0%	26.9 (22.7)	147.5	364.4	896.4	2955.7	0
Farmer-group 86 (Coop 4)	2017	63.6%	14.2	151.8	189.2	357.4	1721.5	0

assistance and competitive prices for produce and inputs. This cooperative also functioned as a middleman for other farmers and FGs in the vicinity, managed a nursery for certified seedlings, and owned land to finance the salaries of its staff. Importantly, it maintained the rules and regulations established during the first cycle of palm oil cultivation, reaffirming its resilience (interviews 72, 77, 84).

Cooperatives 2 and 3 ceased to provide services. Cooperatives 4 and 5 survived the replanting process but provided limited services compared to during the first cycle. By 2021, they were no longer involved in pest and disease management, road maintenance, or in the collective purchase of inputs for their members. Consequently, they are considered as being only partially resilient. However, Cooperative 4 and 5 leaders expressed optimism that more farmers might return once oil palms started producing again, potentially leading to a revival of

activities (interviews 80, 81). They, other FG leaders and individual farmers said that they received substantially lower prices for their product than farmers in Cooperative 1 (interviews 36b, 80, 81; Table 3). The supra-cooperative has not been operational since 2014 and is unlikely to reemerge soon as it was frequently associated with corruption and failed investments (interviews 63, 74, 78, 79).

Although some farmers benefitted from "free-riding" while their organisations were still functioning, many lost both their assets (RU4) and their ideals (A6). These smallholders frequently expressed bitterness about how their FO had functioned; the endless discussions, being forced to do what others decide, and a perceived lack of transparency, plus corruption. Many enjoy the straightforward 'kampung style' independent farmer approach, with direct sales to middlemen, and have no future plan to join an FO (interviews 11, 15, 22, 25). Furthermore, Table 3 shows that many farmers in Cooperative 1 have significant debts to pay off, which led to final payments in Cooperative 1 being, temporarily, lower than in FG 51.

Whereas our focus is on cooperatives, the lack of uniform conditions and absence of yield records from other farmers complicates the comparison of performance. However, some FGs outside Cooperative 1 were also successful. For example, FG 51 (formerly in Cooperative 3) and 86 (in Cooperative 4), achieved reasonable yields, but provided fewer services, sold their produce through middlemen at lower prices, and undertook less collective purchase of fertilisers than Cooperative 1 (see Table 3). These FGs occupy an intermediate position between purely independent farmers and those under Cooperative 1 management.

Besides direct consequences, the demise of FOs in Ophir also had indirect consequences. Pest and disease outbreaks can threaten entire landscapes (Damtew et al., 2020), and fields that are poisoned and underplanted are especially sensitive to pests and diseases carried over from earlier plantings, e.g. species of the herbivorous beetles of the genus *Oryctes* and stem rot caused by the fungus *Ganoderma boninsi* (Beaudoin-Ollivier et al., 2017; PalmElit - CIRAD Inside). In Ophir there is serious concern about outbreaks of Ganoderma, a disease that kills the palms and reduces yields, especially yields of second or third cycle oil palms or palms planted on land where coconuts were grown previously (Corley and Tinker, 2016; Fairhurst et al., 2019). While pests and diseases typically pose the greatest threat to low-input, low-output production systems, Cooperative 1 farmers are particularly susceptible to financial vulnerability in the event of a widespread outbreak of Ganoderma, primarily due to their substantial debts resulting from a complex replanting strategy.

5. Discussion

This paper sheds light on the potential of farmer organisations to contribute to sustainable agricultural intensification. Cooperative 1 is proof that FOs can maintain a high-input high-output collective smallholder plantation and even survive the critical event of replanting. However, we also demonstrate that in many FOs, the rules and regulations have been eroded over time and proved to be less resilient during replanting. Farmers subsequently transitioned to less complex production systems, underscoring the fact that FOs are not a guaranteed key to sustainable intensification. Our findings thus call for caution when interpreting the results of studies that compare, or generalize, farm system models (e.g. Hidayat et al., 2021; Hutabarat et al., 2019; Jelsma et al., 2017b) as these barely account for internal diversity or specific local conditions. Furthermore, our study clearly demonstrates that the actual application of operational rules (GS5) is at least as important as the theoretical basis of a production system (GS7).

Given that most Indonesian smallholders are independent, farmers' characteristics are very varied, oil palms have different ages and grow in different landscapes (Jelsma et al., 2017a; Potter, 2016; Schoneveld et al., 2019), organising farmers in groups is a daunting task. What is more, our study demonstrates that FOs are continually affected by internal and external developments and represent a risk for participants. Without proper external support to ensure farmers have confidence in their FOs and receive guidance towards externally desired development paths, it may well be that many FOs remain empty shells that cannot, or can only partially, facilitate intensive smallholder production systems, or replanting. Whilst the theoretical advantages of FOs appear to be easily overestimated by sustainability initiatives, complexity, costs and risks associated with FOs are easily underestimated.

Whereas trust in CA was maintained in Cooperative 1 and the benefits were significant, in Cooperatives 2–5 trust decreased over time. However, this does not mean that pathways in Ophir were deterministic. In line with the diagnostic possibilities attributed to the IAD based frameworks (Cole et al., 2019; McGinnis and Ostrom, 2014; Ortiz-Riomalo et al., 2023b), policy interventions at either focal or adjacent action situations, may shift farmers' attitudes towards more desirable outcomes. For example, when discussions on land certificates were underway, external professional guidance could perhaps have persuaded enough farmers to make different collective choices. Longer-term support for the farmers in the most difficult circumstances could also have stimulated continuous efforts towards intensive production. Furthermore, if farmers had received more assistance during replanting and government policy had been more accommodating towards intercropping and other farmers' needs, cooperatives might have been able to provide farmers with better replanting strategies. Whilst acknowledging the balance between creating external dependency and independence (Markelova et al., 2009), we argue that additional smallholder support remains necessary throughout the existence of a farmer organisation if certain externally anticipated outcomes are desired, or when conditions prove to be extremely challenging, such as during replanting.

This study contributes to the body of literature on the role of heterogeneity within FOs (e.g. Bijman and Wijers, 2019; Hohler and Kuhl, 2018). While many studies focus on single variables such as farm size, different types of product or contracts (Hohler and Kuhl, 2018), these variables proved of limited relevance in our case since the contracts, plot sizes and product were identical. The strength of the combined IAD-SES-NAS framework, is that it allowed us to develop a more holistic understanding of the links between key variables over a 40-year period, identify why resilience differed among cooperatives and demonstrate how this impacted replanting.

Our findings throw light on the links between bio-physical conditions (RS5; RS9), yields (RU4; RU5), and the age of oil palms (RU7), socio-economic variables such as the farmers' socio-economic conditions (A2), histories (A3), residence and distance to plots (A4), leadership characteristics (A5), norms and levels of mutual trust (A6), the relative importance of oil palm (A8), and governance components such as the presence and absence of government (GS1) and support from development organisations (GS2), and different levels of rules and regulations (GS5, GS6 & GS7). A key finding is that the resource units (RU) of the oil palm plantation were not only FFB and related income, but also land certificates and credit. The mismanagement of credit proved critical for the functioning of the FOs, which escalated during replanting. Thereby it becomes clear that smallholder support for FOs should not only focusses on technical support for oil palm cultivation or replanting, but also particularly on financial management and associated transparency.

We acknowledge, however, that structuring variables using this framework infers relationships, rather than explaining them (McGinnis and Ostrom, 2014; Ostrom, 2011). Also, undoubtedly, we overlooked some relevant events and links. Nevertheless, thanks to the significant amount of fieldwork in Ophir, before, during and after replanting, and the large amount of qualitative and quantitative data we were able to collect during these visits, we are able to present a clear, plausible and empirically supported narrative on what happened in the Ophir plantation over a period of 40 years. This subsequently allows us to draw key lessons on the potential role of FOs in replanting and sustainable intensification.

6. Conclusion

Based on our findings, we draw the following key lessons: 1. Farmer organisations (FOs) can facilitate sustainable intensification and complex replanting strategies, but they are no silver bullet per se. Most cooperatives proved less resilient once replanting was due, leading to the adoption of less intensive replanting strategies there. 2. Recognising the heterogeneity among smallholders, including their backgrounds, support systems and geographic conditions, is critical for understanding why the resilience of FOs differed. Trust and adherence to farmer organisations' rules proved fragile and superficial institutional similarities can hide internal differences that significantly impact resilience of collective action. 3. Smallholder oil palm plantations are much more than mere FFB producing units. Hence, it is crucial to employ holistic approaches encompassing technical, socio-economic, and institutional support for achieving sustainable intensification strategies through FOs. 4. External support is vital not only during the establishment of FOs but also throughout their existence due to constant internal and external dynamics that impact them. 5. To encourage smallholders to embrace and maintain complex and intensive systems, locally devised strategies informed by expert knowledge, scientific input and regular monitoring are essential. Thus, to unlock the full potential of FOs, it is imperative to implement collective action among a much broader range of actors than merely smallholders.

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Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Idsert Jelsma reports financial support was provided by L'Oreal France. Turinah reports financial support was provided by L'Oreal France. Idsert Jelsma reports financial support was provided by Shell Global Solutions International BV.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.agsy.2023.103801.

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