Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/24163
DOI URL: http://dx.doi.org/10.21474/IJAR01/24163

RESEARCH ARTICLE

RETHINKING AGRICULTURAL MECHANISATION FOR THE AGROECOLOGICAL TRANSITION: BENIN'S NATIONAL STRATEGY ASSESSED AGAINST AN IDEAL TYPE

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Manuscript Info

Manuscript History
Received: 10 July 2026
Final Accepted: 12 August 2026
Published: September 2026

Key words:-
policy mix; policy coherence; institutional lock-in; street-level implementation; mechanisation services; West Africa

Abstract

Background: Agricultural mechanisation is expected to raise labour productivity in West Africa, yet it may also deepen soil degradation and social inequalities if it is not aligned with the agroecological transition. This study examines the extent to which Benin's policy and institutional framework is consistent with a form of mechanisation compatiblewith that transition.

Methods: An ideal type of an agroecology-compatible mechanisation policy was built from the FAO's ten elements of agroecology and the HLPE's thirteen principles and translated into seven operational dimensions. The 2022-2026 National Agricultural Mechanisation Strategy (SNMA) and its programme were described as a policy mix and given qualitative ordinal scores from 0 to 2 on each dimension, first on the basis of sixteen policy and legal texts and then on the basis of semi-structured interviews with25 public, private and farmer actors involved in implementation, supplemented by workshop testimonies.

Results: On paper, the strategy reaches six points out of fourteen. It contains operational instruments for the shared use of equipment, which receives nearly a third of the programmed budget, but no eligibility criterion, budget line or indicator for input reduction, soil conservation or diversified cropping systems. An exploratory reading of the in-depth interviews suggests an even wider gap, two points out of fourteen: actors describe a model centred on individual ownership of imported tractors, designed with little input from practitioners and communicated from the top down. Three institutional mechanisms help explain this gap: the lineage of the national operator, an import-based supply chain and distribution-oriented monitoring indicators.

Conclusion: Aligning mechanisation with the transition would require environmental eligibility criteria for support instruments, indicators of actual equipment use and soil effects, and territorial consultation bodies.

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Introduction:-

Agricultural public policies play a central role in steering the development pathways of farming systems, particularly in countries where agriculture is a pillar of the economy and of food security [1]. By structuring intervention frameworks, setting strategic priorities and mobilising financial and human resources, they exert a profound influence on technological progress, innovation and relations between actors within agricultural systems [2], [3], [4]. In this context, agricultural mechanisation is often presented as a lever for modernisation, capable of improving labour productivity, reducing the drudgery of farm work and strengthening the competitiveness of farms [5]. Long neglected in developing countries, it is increasingly regarded as a means of improving the efficiency of agricultural systems [6]. It contributes to the development of food supply chains through improved farming practices [7], alleviates labour shortages and speeds up field operations [8], [9].

The development of mechanisation, however, comes up against a context in which agroecology is gaining ground in policy discourse, owing to concerns about environmental degradation, climate change and the misuse of agricultural land [10]. In Benin, Dugué [11] stresses that the agroecological transition calls for new forms of collective action, and Dorvlo et al. [12] regard a transition towards sustainable mechanisation practices as essential. The challenge is not to replicate the intensive models of industrialised countries but to adopt equipment suited to local agroecological conditions [13]. This ambition has found expression in the rise of the notion of sustainable agricultural mechanisation, understood as an integrated approach that seeks to reconcile economic efficiency, social inclusion and respect for the environment [12], and that makes it possible to replace repetitive and arduous tasks with higher value-added activities at a time when rural labour is becoming scarce [14]. Public policies have gradually incorporated these objectives through institutional reforms and the adoption of international and national strategic frameworks [15], [16], so that in most developing countries mechanisation is now driven by frameworks that pursue productivity and environmental sustainability objectives simultaneously [16].

Nevertheless, many studies point to the poor record of state mechanisationprogrammes in past decades [8]. These programmes failed because of governance problems such as rent-seeking, difficulties in obtaining spare parts and a shortage of qualified operators and technicians [17], [18]. Mrema et al. [19] and Pingali [20] further note that they were not based on a rigorous analysis of actual mechanisation needs, which resulted in poorly targeted and short-lived policies. Several studies also show that mechanisation policies suffer from institutional fragmentation, weak coordination between public and private actors and a mismatch between the instruments deployed (subsidies, tax incentives or import programmes) and the needs of small family farms [21], [7], [22]. Added to this are low levels of public investment, a lack of coherence between sectoral strategies and weak appropriation of policy guidelines by implementing actors [15]. According to Amponsah et al. [23], only an endogenous approach, based on the development of local capacities and the adaptation of technologies to their contexts, can guarantee sustainable mechanisation.

This situation raises the question of coherence between mechanisation policies with productivist objectives and the environmental sustainability requirements that the agroecological transition increasingly imposes [23], [10]. The difficulty, for researchers and decision-makers alike, lies in the absence of a tool for assessing whether the concrete instruments of a mechanisation policy are compatible with these requirements or whether, behind a discourse of sustainability, they perpetuate an unquestioned conventional model. This difficulty gives rise to the following research question: to what extent is the existing policy and institutional framework consistent with the development of agricultural mechanisation compatible with the agroecological transition?

The public policy literature encourages sustainability issues to be treated as interdependent [24], which points to the analysis of policy coherence, operationalised through the concept of the policy mix. According to Rogge and Reichardt [25], this concept refers to a policy made up of a strategy carrying objectives and a set of interacting instruments, whose consistency, coherence, credibility and comprehensiveness can be assessed. Such an analysis makes it possible to move beyond a declarative reading of policy texts to assess how they are translated into practice, and to guard against policies that appear to align with environmental objectives while producing the opposite effects through a poorly articulated combination of instruments [25]. A review of the European Common Agricultural Policy has thus shown that its instruments explicitly devoted to climate and the environment could have delivered far greater benefits had their architecture been more coherent [26]. Ignoring the coherence of mechanisation policies therefore entails the risk of committing substantial public resources without any guarantee of alignment with the agroecological transition objectives that the State promotes elsewhere.

The literature has three limitations in this respect. First, the policy mix framework has mainly been used to analyse energy and climate policies in OECD countries, without being applied to agricultural mechanisation or tested against an agroecological normative framework such as the FAO's ten elements [27] or the HLPE's thirteen principles [28]. Second, analyses of agricultural policy coherence most often rely on a reading of documents alone, without comparing it with the appropriation of instruments by implementing actors, a dimension that is nonetheless decisive in contexts of low administrative capacity [29]. Third, the actual alignment between mechanisation policy instruments and local agroecological transition dynamics remains poorly documented in West Africa.

In view of these shortcomings, this study pursues two aims: first, to assess the gap between Benin's mechanisation policy and a policy compatible with the agroecological transition, using an ideal type built from international agroecological frameworks [27], [28]; and second, to interpret this gap in the light of institutional lock-in mechanisms [30] and of the appropriation of instruments by actors. The principal novelty of the study is methodological. It translates the FAO elements and the HLPE principles, which were designed for farming and food systems as a whole, into seven design criteria against which the instruments of a mechanisation policy can be scored. Two further contributions follow from this grid. The first is the combination of a documentary scoring with an exploratory scoring based on implementing actors, which separates the design gap from the implementation gap. The second, which is empirical, is the application of the grid to Benin and the identification of three lock-in mechanisms that help explain the gap observed. Operationally, the study offers decision-makers evidence for readjusting the design of future support instruments. Section 2 presents the analytical framework and the methodology, Section 3 the results, which Section 4 discusses before the conclusion.

Materials and Methods:-

Analytical framework:

The analytical framework of the study operates at two levels. The first is that of the normative ideal type of a mechanisation policy compatible with the agroecological transition, built from international agroecology frameworks, which serves as the benchmark for assessing the coherence of the existing policy. The second brings together the factors that help to explain the observed gap between this ideal type and reality: the composition of the policy mix, institutional lock-in and the appropriation of instruments by implementing actors.

The ideal type of an agroecology-compatible mechanisation policy:

The ideal type, as theorised by Weber [31], does not describe reality: it is an analytical construct used in three steps, namely the selection of an object that is relevant in terms of values, the construction of an idealised synthesis, and concrete imputation, which consists in confronting this construct with empirical cases [32]. It is this third step that structures the empirical approach of the study: the mechanisation policy is analysed not in absolute terms but in terms of the distance that separates it from the constructed ideal type. The approach is enjoying renewed use in comparative public policy analysis. It has been used to quantify qualitative data in the comparative analysis of social protection regimes [32], a logic that can be transposed to the comparison of agricultural policies; its heuristic function in comparative political economy has been reaffirmed, provided that its analytical rather than descriptive character is acknowledged [33]; and the conditions for its rigorous use in a qualitative case study have also been specified [34].

The ideal type adopted here transposes two consolidated normative frameworks into design criteria for a public policy. The FAO's ten elements of agroecology [27] are a tool intended to help countries operationalise agroecology; they cover diversity, co-creation and sharing of knowledge, synergies, efficiency, recycling, resilience, human and social values, culture and food traditions, responsible governance, and circular and solidarity economy. These elements have been consolidated into thirteen principles, which include recycling, input reduction, soil health, biodiversity, synergy, economic diversification, co-creation of knowledge, fairness, connectivity, land and natural resource governance, and participation [28], [10]. Applied to mechanisation, the translation of these two frameworks into seven operational dimensions provides the normative grid of the study (Table 1).

Table 1: Grid of the seven dimensions of the ideal type of an agroecology-compatible mechanisation policy

Dimension	Source principles	Operational criterion applied to mechanisation policy	Summary indicator
D1. Input reduction and recycling	Recycling; input reduction [28]	Instruments support equipment that limits dependence on synthetic inputs (direct seeding, biomass management)	Dedicated budget lines or eligibility criteria; types of equipment

Dimension	Source principles	Operational criterion applied to mechanisation policy	Summary indicator
		rather than equipment calibrated for intensification	promoted
D2. Diversity and economic diversification	Diversity; economic diversification [27], [28]	The mix covers a range of equipment scales (manual, animal traction, small-scale motorisation) and is not centred on a single technological model	Budget allocation across equipment categories; types of equipment promoted
D3. Knowledge co-creation	Co-creation and sharing of knowledge [27], [28]	Research and advisory mechanisms formally involve local manufacturers and farmers in equipment design	Existence of formal consultation or co-design mechanisms
D4. Equity and participation	Fairness; participation [28]	Eligibility criteria do not structurally exclude smallholders, women and young people	Differentiated measures; effective access rate by category
D5. Responsible governance of resources	Land and natural resource governance; soil health [27], [28]	Instruments explicitly link mechanisation with soil and water conservation	Environmental conditionalities attached to support
D6. Connectivity and circular economy	Connectivity; circular and solidarity economy [27], [28]	Instruments support the shared use of equipment (cooperatives, service providers)	Dedicated mechanism for shared mechanisation services
D7. Resilience and synergies	Resilience; synergies [27], [28]	Equipment and advisory services are designed for diversified systems (intercropping, rotations) rather than for monoculture alone	Explicit reference to complementarity between supported equipment and diversified practices

Source: grid constructed by the authors from [27] and [28].

Construction of the ideal type:-

The grid in Table 1 was built in four steps. First, the ten FAO elements and the thirteen HLPE principles were listed and paired where they designate the same property of a farming system, as with the co-creation of knowledge, present in both frameworks, or with recycling and input reduction. Second, an element or principle was retained only if a mechanisation policy instrument, namely an eligibility criterion, a budget line, a consultation mechanism or a monitoring indicator, could plausibly act on it. Third, the retained items were merged when they would be made operational by the same type of instrument: fairness and participation both concern the rules of access to support (D4), while connectivity and the circular and solidarity economy both concern the organisation of shared equipment services (D6). Fourth, each resulting dimension was given an operational criterion and a summary indicator (Table 1).

Six items were not retained as separate dimensions. Animal health, social values and diets, and culture and food traditions lie outside the reach of mechanisation instruments. Efficiency, biodiversity, and human and social values were not dropped but absorbed into the dimensions whose instruments address them most directly, namely input reduction (D1), diversified systems (D7) and equity (D4). The number seven is therefore the outcome of this procedure rather than a target set in advance. The seven dimensions carry equal weight: the FAO and the HLPE present their elements and principles as interdependent without ranking them, and a weighting would have introduced a normative hierarchy that neither framework provides. The grid was constructed by the authors and has not been validated by an independent panel of experts. Another researcher starting from the same frameworks could merge the items differently, which is why the correspondence between each dimension and its source principles is reported in full in Table 1.

The ideal type does not define agroecology-compatible mechanisation by a list of mandatory technologies. Motorised equipment is not excluded, and none of the practices often associated with the transition, such as reduced tillage, direct seeding, diversified cropping, shared ownership, local manufacturing or lower fossil-fuel use, is treated as a necessary condition on its own. These practices enter the grid as means of meeting a dimension: reduced tillage, direct seeding and limited soil disturbance relate to D1 and D5, diversified cropping to D7, shared ownership to D6, and local manufacturing to D2 and D3. A policy is considered compatible to the extent that its instruments

make these dimensions conditions of access to support or objects of monitoring. Fossil-fuel use is covered only indirectly, through D1, which is a limitation of the grid.

The policy mix as the second term of the comparison:-

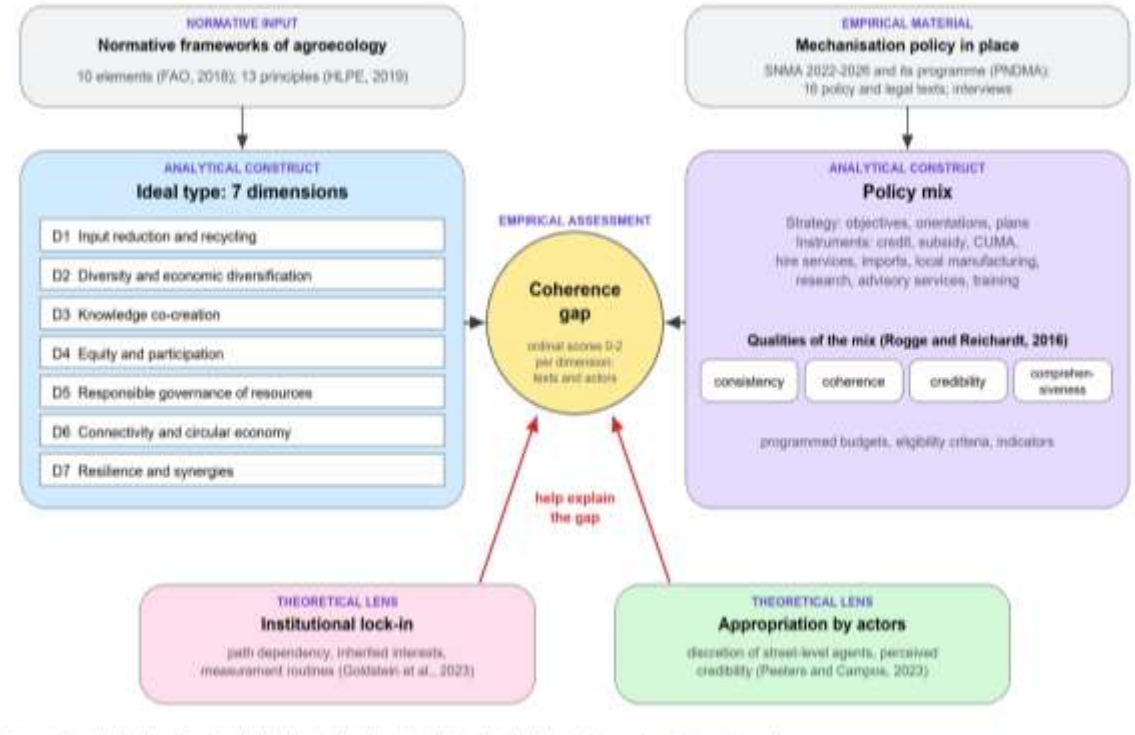
The second term of the comparison is established through the policy mix framework, which breaks a policy down into a strategy carrying objectives and plans and a set of interacting instruments, assessed in terms of the consistency of its elements, the coherence of its processes, its credibility and its comprehensiveness [25]. Widely used in the analysis of energy and climate transitions, this framework makes it possible to document, instrument by instrument, how the mechanisation policy is positioned with respect to each of the seven dimensions of the ideal type.

Two explanatory bodies of literature: institutional lock-in and appropriation:-

Two complementary bodies of literature are drawn upon to interpret the gap. The first is the literature on path dependency and lock-in [30]. Instruments inherited from an earlier trajectory generate institutionalised interests, such as an import channel for motorised equipment, historical funding from partners or administrative habits, which make any reorientation costly, even when it is formally announced in policy texts [30]. This phenomenon has been documented in Europe, where the OECD observes that the Common Agricultural Policy struggles to overcome its path dependency and that its successive reforms have produced only incremental progress [35]. The second body of literature concerns the appropriation of instruments by the actors responsible for implementing them.

The coherence of a policy is not settled at the design stage alone: it is reshaped during implementation through the discretion exercised by street-level agents, which is particularly decisive in institutional contexts of low administrative capacity [29]. The gap observed in the texts may therefore differ markedly from the gap perceived by actors, since the credibility of an instrument is socially constructed between stated intentions and actual practices.The resulting analytical model combines three components (Figure 1). The seven-dimension ideal type serves as the reference; the description of the policy mix actually in place constitutes the second term of the comparison and yields a gap that can be assessed dimension by dimension; and institutional lock-in and appropriation by actors are used to interpret this gap, complementing a descriptive reading with a dynamic and institutional reading of its causes.

Fig. 1. Analytical framework of the study



Source: research data, 2026

Overall approach and documentary corpus:

The study adopts a qualitative case study approach based on comparison with an ideal type. This choice reflects the nature of the object: the aim is to characterise the coherence between a normative framework and a complex institutional object, namely the instruments in place, and then to explain the underlying mechanisms on the basis of the meaning that actors attribute to them. The approach combines two sources of data. The first is documentary and consisted in identifying the relevant policy and legal texts (Table 2), together with the scientific literature on agricultural policy analysis.

Table 2: Policy documents and legal texts consulted

Year	Title
2022	Law No. 2022-14 of 9 July 2022 on agricultural orientation and food and nutrition security in the Republic of Benin [36]
2017	Law No. 2013-01 on the Land and State Property Code, amended in 2017
2007	Decree No. 2007-090 of 28 February 2007 on the establishment, powers, composition and functioning of the National Council for Agricultural Mechanisation
2016	Decree No. 2016-65 of 10 March 2016 approving the statutes of the Agricultural Mechanisation Development Agency (ADMA-SA)
2019	Decree No. 2019-123 of 10 April 2019 approving the statutes of the National Agricultural Mechanisation Agency
2005	National Agricultural Mechanisation Strategy (SNMA 2006-2015)
2021	National Agricultural Mechanisation Strategy (SNMA) of Benin 2022-2026 [37]
2017	Strategic Plan for Agricultural Sector Development (PSDSA) 2025 and National Agricultural Investment and Food and Nutrition Security Plan (PNIASAN) 2017-2021 [38]
2017	Second-generation National Agricultural Investment and Food and Nutrition Security Plan
2011	Strategic Plan for the Revitalisation of the Agricultural Sector (PSRSA)
2010	Agricultural Investment Plan 2010-2015
2017	Agricultural Sector Programming Framework
2021	Government Action Programme 2021-2026
2022	National Strategy for the Development of Ecological and Organic Agriculture in Benin (SNDAEB-Bénin) [39]
2017	Land Degradation Neutrality: policy brief on targets and measures
2025	National Policy for the Promotion and Development of Small and Medium-sized Enterprises (PNPDPME) 2025-2034

Source: documentary research, 2026

The documents were identified from the references cited by actors during the exploratory interviews conducted at the start of the research. They were then retrieved from the official websites of the institutions concerned and, for working documents that are not published online, obtained directly from the actors who hold them. A text was included if it either prescribes an orientation for agricultural mechanisation or organises the actors responsible for implementing it. Institutional communication without prescriptive scope and annual activity reports were excluded, since their contribution was limited to implementation data already reported in the strategies. The corpus is therefore purposive rather than exhaustive. It includes the action sheets and budget annex of the SNMA, but no budget execution report and no FNDA document on the subsidy and credit envelope were available to the authors. The documents span 2005 to 2025 and were read in the light of their date: the SNMA, finalised in August 2021, predates the SNDAEB of November 2022.

Study area and selected case:-

Benin is a West African country where farm mechanisation remains limited: according to the 2019 National Agricultural Census, 12.41 per cent of farms engaged in crop production mechanise their tillage, animal traction included, with wide disparities between the cotton-growing north and the rest of the country [40]. To make its agricultural sector more competitive, the country has adopted a National Agricultural Mechanisation Strategy (SNMA) [37]. At the same time, in response to declining soil fertility, policy ambitions show growing interest in the agroecological transition, as evidenced by the adoption of a National Strategy for the Development of Ecological and Organic Agriculture (SNDAEB) [39]. The Beninese context thus offers a relevant setting for understanding how mechanisation policy and the imperatives of the transition fit together, beyond the tensions between these two notions highlighted in the literature. Throughout the article, ‘the SNMA’ refers to the strategy document and ‘the

Programme' to the PNDMA through which it is implemented. The policy case selected is the SNMA 2022-2026 and the National Agricultural Mechanisation Development Programme (PNDMA) derived from it, whose instruments are deployed in an environment marked by agroecological transition initiatives led by the State and its partners.

Data collection methods and tools:-

Two types of data were collected. Documentary data were extracted from the corpus using a reading grid structured around the seven dimensions in Table 1; they cover the history of mechanisation policies, the instruments deployed by the strategy, their programmed budgets and indicators, and their fit with the dimensions of the ideal type. Additional data were gathered through semi-structured interviews, conducted with an interview guide, with the actors involved in implementation (Table 3): officials of the Ministry of Agriculture, Livestock and Fisheries (MAEP), the departmental directorates (DDAEP), the Territorial Agencies for Agricultural Development (ATDA) and the municipal units; officials of the National Agricultural Mechanisation Company (SoNaMA); advisory and training organisations; financial services; and beneficiaries, whether farmers, mechanisation service providers, mechanics or local manufacturers.

Sampling was purposive: interviewees were selected for their position in the implementation chain, and further actors were identified through referrals from those already interviewed. The interviews covered actors' knowledge of the strategy's guidelines, their appropriation of them, the inconsistencies perceived in implementation and their general perceptions of the policy. They were supplemented by testimonies recorded during the workshop of the innovation platform of Agricultural Development Pole 2 (PDA 2) held in Kandi on 20 and 21 February 2025. The recorded interviews were transcribed, then reread and corrected before analysis. All interview excerpts quoted in this article were translated from French by the authors.

Table 3: Interviews conducted by stakeholder category

Stakeholder category	Number interviewed	Location	Role in implementation
National government (MAEP, DGR)	2	Cotonou	Policy design, monitoring and evaluation
Decentralised services (DDAEP, ATDA, municipal units)	6	Kandi, Banikoara, Bembèrèkè	Transfer of know-how, support to farmers
SoNaMA	2	Kandi	National operator: supply, services, coordination
Advisory and training organisations (AIC, Chinese agricultural mission, NGOs)	3	Kandi	Advisory services and training
Financial services	3	Kandi	Credit for equipment
Farmers and CUMA	5	Kandi	Equipment users
Mechanisation service providers	2	Kandi	Hire services
Mechanics and local manufacturers	2	Kandi	Maintenance, repair and local manufacturing
Total	25		

Source: fieldwork, From 6 to 14 January 2025.

The interviews were conducted between 6 and 14 January and lasted approximately one hour each; two of the interviewees were women. Saturation was assessed category by category rather than for the sample as a whole. Within each stakeholder category, interviews continued until the latest ones no longer brought new elements on the seven dimensions or on the functioning of the implementation chain, and the final interviews mainly confirmed themes already identified, such as the central role of the national operator, the ad hoc nature of consultations and the absence of environmental conditions attached to support [41]. This criterion was applied within the limits of a purposive design: categories with few potential informants, such as the national operator, could not be extended at will.

Data analysis methods:-

The data were analysed through content analysis. Each dimension in Table 1 was coded deductively on a three-level ordinal scale, applied separately to the documentary data and to the interview data in accordance with the principles of thematic analysis [41]. For the texts, a score of 0 indicates that the dimension is absent, a score of 1 that it is

mentioned without any instrument, budget, criterion or indicator to make it operational, and a score of 2 that it is supported by an identifiable instrument accompanied by a budget or an indicator. For the interviews, a score of 0 indicates that actors describe the absence of the dimension or a contrary practice, a score of 1 partial consideration, and a score of 2 consideration that they regard as effective.

Borderline cases were settled by the wording of the scale. In the texts, a dimension mentioned in the vision, the diagnosis or the implementation strategy of an action, but not attached to a budget line, an eligibility criterion or an indicator, was scored 1, whatever the emphasis of the wording; a score of 2 required both an identifiable instrument and a budget or an indicator. In the interviews, a dimension was scored 1 when actors reported changes in its direction but attributed them to ad hoc decisions rather than to an instrument of the strategy. The interview score for each dimension was assigned from the whole set of coded excerpts relating to that dimension rather than by averaging individual interviews, and evidence of contrary practice took precedence over isolated favourable statements. The excerpts supporting each score are reported in Table 5. Coding was carried out manually, without qualitative analysis software, by one author, and the codes and scores were then checked by the other co-authors against the supporting excerpts. No intercoder agreement coefficient was calculated, since the material was not coded independently by two researchers.

The interview scores were assigned from an analytical subset of the interview material: the two in-depth interviews that were fully transcribed and coded, one with a territorial official of ATDA Pole 2 and one with an adviser from an agricultural NGO, both conducted in January 2025 and the testimonies recorded at the February 2025 workshop. The other interviews were used to identify the categories of actors, the documents and the implementation chain, but have not yet been coded on the seven dimensions. The perceived scores are therefore exploratory, and this article treats them as indications of the implementation gap rather than as a measurement of it.

The resulting scores are ordinal categories, not measurements. The totals out of 14 serve only to summarise the profile across dimensions; they are not an index with statistical properties, and a difference of one point does not represent the same distance on every dimension. The gap relative to the ideal type corresponds to the difference between the maximum score of 2 and the score obtained. The content analysis of the interviews was also used to identify institutional lock-in mechanisms and forms of discretionary appropriation of the instruments.

Researcher positionality and reflexivity:-

One of the authors serves as secretary of the PDA 2 innovation platform. This position facilitated access to actors and to working documents, but it is not neutral with respect to the object of study, since the platform brings together actors whose relations with the national operator are analysed here. Several precautions were taken. The interview sample covered the officials in charge of implementation, including those of the national operator, and not only actors critical of the policy. Statements that run against the dominant view, such as the improvements that actors attribute to the national operator, were retained and are reflected in the partial scores for D2 and D6. Every score is documented with a verifiable excerpt from the texts or the interviews (Table 5), so that readers can assess it independently, and the coding carried out by one author was checked by the co-authors.

Results:-

Historical trajectory of mechanisation in agricultural policies:-

Beninese public action on mechanisation starts from an agriculture dominated by human energy. For sub-Saharan Africa as a whole, Side and Havard [42] estimate that 65 per cent of the energy used in agricultural production comes from humans, 25 per cent from animals and 10 per cent from engines; this regional estimate, published in 2014, is not directly comparable with national figures. For Benin, the SNMA reports that 76 per cent of tillage is done manually, 23 per cent with animal traction and only 1 per cent with motorised equipment [37, pp. 5, 28]. The strategy attributes these figures at times to the 2011 Strategic Plan for the Revitalisation of the Agricultural Sector and at others to the 2006 mechanisation policy document, so they describe the situation at the end of the 2000s rather than in 2021. They are also measured differently from the 2019 census figure cited above, which refers to the share of farms that mechanise their tillage. Animal traction expanded in the 1980s thanks to COBEMAG and the Boko animal traction centre [37, p. 5], while motorisation remained marginal. The late 1990s were marked by the omission of mechanisation from policies and the termination of research and training programmes; farmer initiatives then took over, foremost among them the cooperatives for the shared use of agricultural equipment (CUMA), the first of which was founded in 1997 in Ina [37, p. 48]. Collective access through farmer organisations remains, alongside individual ownership, one of the two ways of managing machinery that Beninese farmers prefer [43].

Between 2005 and 2015, public intervention returned through the supply side. The first SNMA (2006-2015), drawn up with FAO support, was barely implemented, for lack of steering tools and of a monitoring and evaluation system. The Agricultural Mechanisation Promotion Programme (PPMA) organised the import of more than one thousand tractors and implements and then gave rise to the Agricultural Mechanisation Development Agency (ADMA), which was liquidated in 2017 [37]. The record of the decade combines low adoption, underuse of equipment, recurrent breakdowns, the absence of after-sales service, the politicisation of interventions and competition from the State that private importers regarded as unfair, with quantitative progress: the SNMA reports that the rate of motorisation of activities rose from 2 to 20 per cent between 2005 and 2015 and that the number of CUMA increased by more than 500 per cent over the same period [37, p. 12].

Since 2016, the State has refocused implementation on a national operator, the National Agricultural Mechanisation Agency (ANaMA), established in 2019 and converted into the National Agricultural Mechanisation Company (SoNaMA S.A.) in 2021. The SNMA 2022-2026 sets out a 2030 vision of mechanisation that is 'sufficient, sustainable, adapted to the socio-economic context of actors and to environmental (or agroecological) conditions' [37]. This trajectory reveals a shift towards operational sustainability, built on the structuring of services, credit and maintenance, whose agroecological dimension has yet to be established. This is the subject of the following sections.

Characterisation of the policy mix of the SNMA 2022-2026:-

The SNMA is implemented through a single programme, the National Agricultural Mechanisation Development Programme (PNDMA), whose overall objective is 'to develop environmentally friendly agricultural mechanisation' [37, p. 59]. The Programme is organised into two orientations, five axes and fourteen actions, with a programmed cost of 22.085 billion CFA francs (Table 4). The first orientation, which concerns access to equipment 'for the benefit of the different categories of farmers, including women and young people' [37, p. 57], accounts for 58.8 per cent of the programmed budget; the second, which concerns equipment use practices and human capital, accounts for 41.2 per cent. These amounts are programmed allocations taken from the action sheets and budget annex of the SNMA; they do not indicate what has actually been spent.

Table 4: Policy mix of the National Agricultural Mechanisation Development Programme (PNDMA): programmed budget allocation

Axis	Actions (instruments)	Programmed cost (FCFA billion)	Share (%)	Dimensions concerned
1.1. Farmer investment	Adapted credit system (1.1.1); 'smart' subsidy system (1.1.2)	0.310	1.4	D1, D4
1.2. Service access models	Strengthening of the CUMA network (1.2.1); organisation of hire service providers (1.2.2)	6.905	31.3	D6, D4
1.3. Private supply sector	Promotion of imports and digitalisation (1.3.1); promotion of local manufacturing (1.3.2); network of maintenance technicians (1.3.3); revaluation of idle assets (1.3.4)	5.780	26.2	D3, D2
2.1. Techniques adapted to the local context	Research and development in crop and post-harvest (2.1.1), livestock (2.1.2) and fisheries (2.1.3) production; advisory programme on equipment use (2.1.4)	6.500	29.4	D3, D1
2.2. Training	Training programmes (2.2.1); strengthening of training institutions (2.2.2)	2.590	11.7	D3
Total	14 actions	22.085	100	

Source: compiled from the action sheets and budget annex of the SNMA [37, pp. 60–84, 99].

Amounts are programmed allocations, not expenditure:-

Three features stand out in this mix. First, the two financial instruments that most directly determine the type of equipment acquired, credit and subsidies, account for only 1.4 per cent of the costed budget. This share must be read with care, because it covers only the preparatory studies and texts of the two actions: the SNMA states that their costing excludes the interest-rate subsidy, the guarantee fund and the subsidy envelope itself [37, pp. 61, 63], which are referred to the National Agricultural Development Fund (FNDA). Three levels therefore need to be distinguished: the budget explicitly costed in the SNMA, the financial resources on which the strategy relies but which are managed by the FNDA, and actual expenditure, which is documented for neither. The 1.4 per cent share does not measure the financial weight of credit and subsidies; it shows that the conditions attached to them are not set within the strategy.

The subsidy is presented as a means of steering investment towards activities 'with no negative social or environmental effects', and the strategy cites equipment for conservation agriculture as an example of what should be prioritised, yet its indicators are limited to the 'percentage of farmers who have received a subsidy' and the 'rate of consumption of the allocated budget' [37, p. 63]. Second, shared use is the largest item of the programmed budget, with FCFA 6.905 billion, or 31.3 per cent, allocated to the CUMA network and to hire service providers [37, pp. 64–66]. This allocation concerns the creation and strengthening of shared-service structures. The SNMA counts 146 CUMA at the time of its preparation [37, p. 48], but the documents consulted provide no data on the number of CUMA actually functioning, the number of farmers they serve or the utilisation rate of their equipment. Finally, supply relies on a dual arrangement of imports and local manufacturing, the former backed by technical specifications and a planned equipment approval centre, the latter by capacity building for artisans and access to credit; in both cases, a shortlist of suppliers is to be selected to access the Programme's incentives [37, pp. 68–71].

Assessing the gap between the ideal type and the SNMA:-

Scoring the seven dimensions shows a substantial gap between the ideal type and the strategy (Table 5; Figure 2). At the documentary level, the SNMA reaches 6 points out of 14. Only one dimension, the shared use of equipment (D6), is backed by operational instruments; four are mentioned without an operational instrument (D1, D3, D4, D5); and two are absent (D2, D7). In other words, apart from shared use, the strategy contains few operational instruments corresponding to the agroecological dimensions defined in the ideal type.

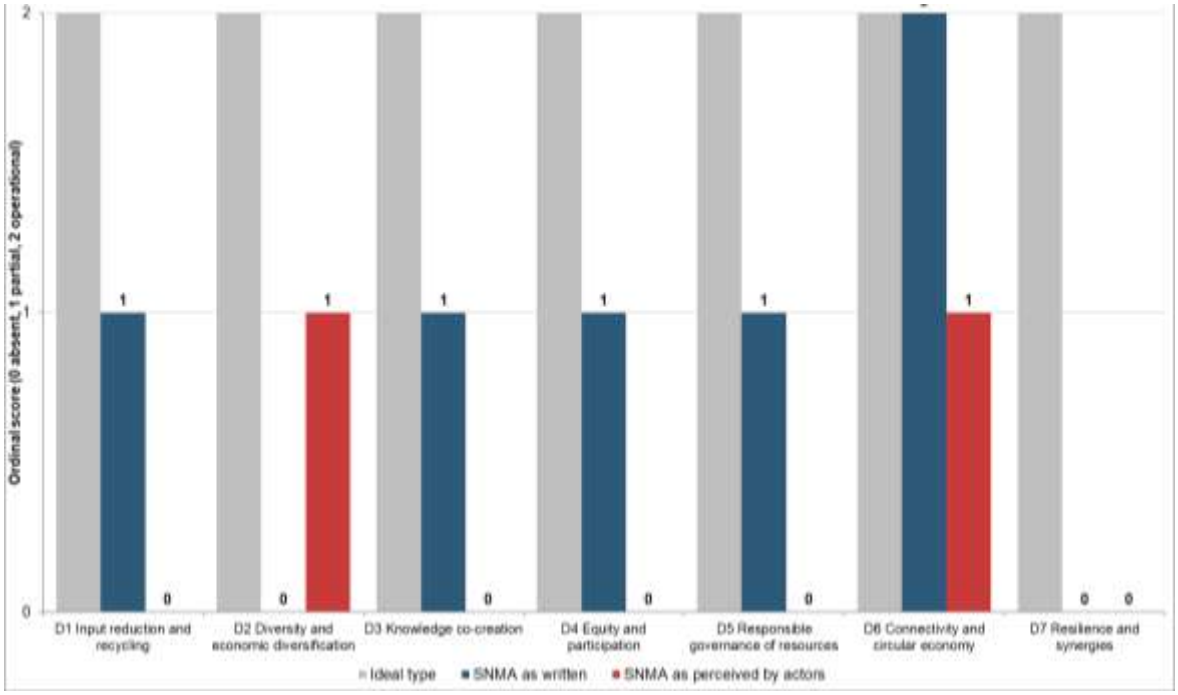
Table 5: Scores for the seven dimensions in the texts and in the interviews (0 to 2)

Dimension	Score (texts)	Evidence from the texts	Score (actors)	Evidence from the interviews
D1. Input reduction and recycling	1	Subsidy directed towards equipment 'contributing to environmental protection', with conservation agriculture as an example (Action 1.1.2 [37, p. 63]); no budget line, eligibility criterion or indicator	0	Kits centred on ploughing; seed drill mentioned as an unmet need; no mention of support for direct seeding equipment (interviews; February 2025 workshop)
D2. Diversity and economic diversification	0	Programme targeted at 'modern agricultural equipment' [37, pp. 57, 60]; animal traction and hand tools mentioned in the diagnosis [37, pp. 5, 28] but absent from the actions	1	Power tillers offered alongside tractors; 'mechanisation is not just the tractor', a territorial official points out; animal traction maintained by default (ATDA interview)
D3. Knowledge co-creation	1	Manufacturers, artisans and farmers listed among the bodies involved in research and development; indicators limited to the number of prototypes and publications (Action 2.1.1 [37, p. 76])	0	'Intellectualised' strategy, drawn up without practitioners; manufacturers and CUMA consulted on an ad hoc basis (ATDA interview; interview in Kandi, April 2025)

Dimension	Score (texts)	Evidence from the texts	Score (actors)	Evidence from the interviews
D4. Equity and participation	1	Orientation 1 open to women and young people [37, p. 57]; 'particular interest' in cooperatives, women and young people in the credit criteria (Action 1.1.1 [37, p. 61]); indicators not disaggregated	0	Farmer representatives chosen from among those with large landholdings or who speak French; logic of individual satisfaction (ATDA interview)
D5. Responsible governance of resources	1	Vision 'adapted to environmental conditions' [37, p. 54]; no environmental conditionality attached to credit or subsidies (Actions 1.1.1 and 1.1.2 [37, pp. 60–63])	0	No conditionality known to actors; erosion and deforestation cited among the effects of mechanisation (interviews)
D6. Connectivity and circular economy	2	Actions 1.2.1 and 1.2.2: FCFA 6.905 billion (programmed), indicators on the creation of cooperatives and service enterprises [37, pp. 64–66]	1	Services tracked by geolocation, local clusters (ATDA and NGO interviews); but a model perceived as geared towards individual ownership (ATDA interview)
D7. Resilience and synergies	0	No mention of intercropping or rotations; research organised by agroecological zone and by value chain (Action 2.1.1 [37, p. 76])	0	Equipment row spacings unsuited to crop diversity; specialisation by value chain rather than by system (interviews, including the ATDA interview)
Total	6 / 14		2 / 14 (exploratory)	

Source: content analysis of the SNMA 2022-2026 [37] and of the interviews (2025). Scores are ordinal (0 absent, 1 partial, 2 operational); totals summarise the profile and are not an index; actor scores are exploratory (see Section 2).

Fig 2: Ordinal scores of the SNMA as written and as perceived by actors on the seven dimensions of the ideal type.



Source: research data, 2026

Figure 2 is a grouped bar chart. Each bar indicates the level reached on a dimension, and the height of the bars should not be read as a quantity.Read through the four qualities identified by Rogge and Reichardt [25], this profile sheds light on the composition of the mix. Consistency is limited, because the overall objective of 'environmentally friendly' mechanisation is not carried through by any instrument that would make it a condition of access.

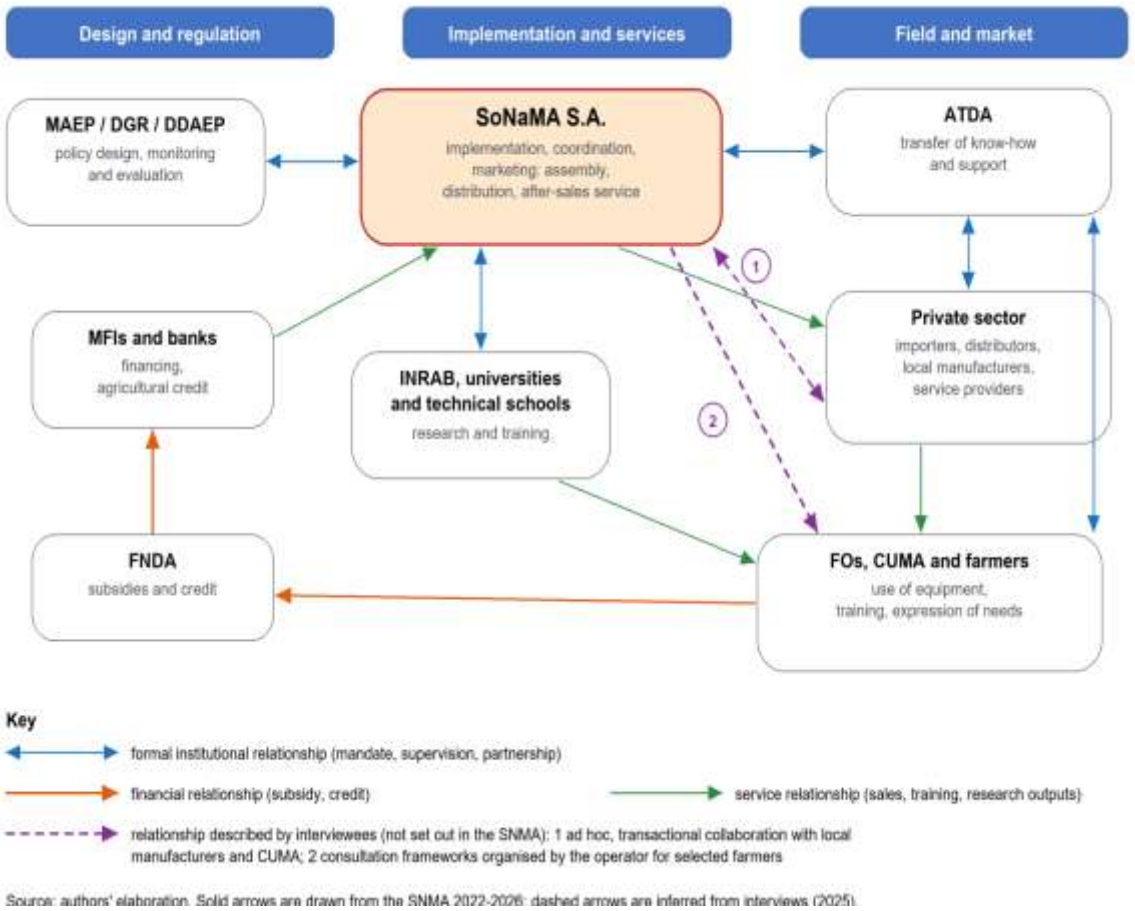
Coherence with other policies is one-sided: the SNDAEB, adopted in November 2022, declares itself consistent with the mechanisation component of the PSDSA and provides for the development of production technologies including mechanisation, but the SNMA, finalised in August 2021, could not refer to it, and no mechanism is foreseen to link the two strategies [39], [37]. Credibility is undermined by the strategy itself, which lists among its risks the 'weak appropriation of the Policy by stakeholders', the 'spontaneous change of strategic option by the authorities' and the 'heavy dependence of the system on external funding' [37, p. 88]. Comprehensiveness, finally, is realas regards access and human capital, but the mix covers neither environmental conditionality, nor fuel supply, nor the monitoring of the actual use of equipment.

Credibility as perceived by implementing actors:-

Organisational framework of mechanisation actors:-

The SNMA organises implementation around SoNaMA, which resulted from the conversion of ANaMA in 2021 (Figure 3). This public limited company combines responsibilities for coordinating, monitoring and implementing national policy with commercial and industrial tasks of assembly, distribution and maintenance, which places it in the position of both delegated regulator and market operator. The Directorate of Rural Engineering (DGR) retains responsibility for design and for monitoring and evaluation, the ATDA are in charge of transferring know-how, the FNDA manages subsidies and credit in partnership with financial institutions, and research and training fall to the National Institute of Agricultural Research of Benin (INRAB) and to university and technical institutions. Lastly, the strategy recognises CUMA as the reference structure for the collective use of equipment and calls on the private sector (importers, distributors, manufacturers and service providers) to build a viable market [37].

Fig 3: Overview of the actors in the organisational framework of agricultural mechanisation in Benin, by type of relationship.



Source: research data, 2026

The strategy itself notes that competition from the State is an obstacle to the emergence of an autonomous private supply [37]. On the ground, collaboration between SoNaMA and other actors appears limited and transactional.

A local manufacturer and a CUMA facilitator describe it in identical terms:-
'We have no formal partnership with SoNaMA; we are only called upon when they need us. Once the job is done, the relationship ends, keeping us in a vicious circle of discontinuity.'
Excerpt from an interview with O. W., Kandi, 12January 2025; translated from French

Comparison with credibility as perceived by field actors:-
Comparing documentary and perceived scores suggests that the gap widens from design to implementation, from 8 to 12 points out of 14. Given the exploratory basis of the perceived scores, the four observations below are reported with their sources, and their empirical weight differs.
The first observation concerns the dimension best provided for on paper, shared use. Although nearly a third of the programmed budget is allocated to it,

The ATDA official interviewed describes an implementation geared towards the individual satisfaction of farmers:-
'Today, we are in a logic of trying to satisfy farmers individually. […] It is difficult to sell a tractor to an individual and think that this is how mechanisation is being developed.'
Excerpt from an interview with a territorial official, ATDA Pole 2, Kandi, January 2025; translated from French

The official contrasts this model with the equipping of farmer groups, which would have made it possible to reach the objectives more quickly, and anticipates its cost, the risk being, in the official's words, that of 'sending it all for scrap'.

Shared services do exist, but in the interviews they appear to stem from local initiatives rather than from the instruments of the strategy: the NGO adviser interviewed describes farmer clusters in which service providers charge members a reduced rate. This observation rests on two interviews, the ATDA official's and the NGO adviser's, and is reported as an indication rather than as a general pattern.

The second observation concerns co-creation. The same official describes the strategy as 'intellectualised': 'We did not want to listen to those who are not graduates […] but who acquired their knowledge through practice', citing the repair artisan in Kérou as'the best placed to tell you how the equipment should be sized'.

Excerpts from the same interview, ATDA Pole 2, January 2025; translated from French:-

Testimonies gathered at the innovation platform workshop held in Kandi on 20 and 21 February 2025 illustrate the consequences of this lack of dialogue. One farmer reports that in the village 'nobody uses the mouldboard plough' because it breaks on roots, and the representative of the mechanics' network immediately generalises:

'I know several farmers who contacted me after buying their tractor to help them find a disc plough to replace the coulterplough they'd been sold at SoNaMA.'

Testimony of the representative of the mechanics' network, PDA 2 innovation platform workshop, Kandi, 20-21 February 2025; translated from French

Unlike the first, this observation recurs across sources and stakeholder categories: the exclusion of practitioners from equipment design is raised by the territorial official, by a farmer and by the representative of the mechanics' network at the workshop, and the ad hoc nature of relations with the national operator is described in January 2025 interview in Kandi. The third observation relates to equity and participation. According to the ATDA official, the consultation frameworks organised by the operator bring together farmers selected among those farming large areas, those who have faced many difficulties and those who speak French. This description comes from a single interview. The criterion of 'particular interest' in women and young people set out in the strategy was not mentioned in the interviews coded. As a point of reference, the 2019 census indicates that 7.34 per cent of the farms that mechanise their tillage in the Alibori Sud-Borgou Nord-2KP pole are headed by women [40].

The fourth observation concerns appropriation itself. The territorial official interviewed learns of policy orientations after they have been adopted: 'Perhaps it is because I am not at the level of the decision-makers. It is when the information comes here that we find out about it.' The same official acknowledges changes of direction introduced by the national operator, such as the introduction of soil preparation equipment other than tractors and ploughs, staggered payments backed by the FNDA and the specialisation of supply by value chain, which accounts for the partial scores assigned to D2 and D6. These changes are attributed to the operator rather than to the strategy, which suggests that the credibility of the policy is built through the action of a single actor more than through its instruments. Because this observation rests mainly on one interview, it will need to be tested on the full interview corpus.

Institutional lock-in mechanisms identified:-

Three lock-in mechanisms help explain the persistence of the gap (Table 6). For each of them, Table 6 separates the evidence, the institutional behaviour observed and the interpretation drawn from the literature on path dependency and lock-in [30].

Table 6: Institutional lock-in mechanisms: evidence, observed behaviour and theoretical interpretation

Mechanism	Evidence (texts and interviews)	Observed institutional behaviour	Interpretation in the lock-in literature [30]	Dimensions affected
Lineage of the national operator	PPMA, ADMA, ANaMA, SoNaMA chain; Action 1.3.4 on revaluing the assets inherited from the PPMA and ADMA-SA; about FCFA 3.5 billion of unpaid debts for equipment supplied in 2008-2011 [37, p. 73]	The operator combines regulatory and commercial functions, organises consultations and is perceived as the main source of information (ATDA interview)	Inherited organisations and assets create interests in continuity: settling the past favours familiar equipment	D3, D4, D6

Mechanism	Evidence (texts and interviews)	Observed institutional behaviour	Interpretation in the lock-in literature [30]	Dimensions affected
Import-based supply chain	Action 1.3.1 on import promotion and shortlist of approved suppliers [37, pp. 68–71]; local manufacturing mainly oriented towards post-harvest equipment [37, p. 34]; 'You go and see your Indian friend…' (ATDA interview)	Equipment chosen through relations with supplier countries rather than soils and crops; standardised kit composition	Economic interests built around a supply channel make reorientation costly	D1, D2, D7
Distribution-oriented indicators	Indicators on beneficiaries, budget consumption and a 50 per cent increase in demand [37, pp. 61–69]; use indicators limited to tractor hours and the repair of idle machines [37, pp. 72, 74] (Table A1)	Monitoring of tractors delivered and hectares worked through geolocation; no monitoring of unused implements or of effects on soils (ATDA interview)	Measurement routines render alternatives invisible	D1, D5, D7

Source: content analysis of the SNMA [37] and of the interviews (2025); interpretation based on [30].

The first mechanism is the lineage of the national operator. SoNaMA inherits an institutional chain running from the PPMA to ADMA and then to ANaMA, and the strategy entrusts it with revaluing the stock of equipment inherited from these structures, which, the strategy recalls, left some 3.5 billion CFA francs in unpaid debts for the equipment supplied between 2008 and 2011 alone [37, p. 73]. This legacy weighs on the design of instruments: the operator must both settle the past and develop a commercial offer, which may encourage it to favour the equipment it already knows. The second mechanism is a supply chain built on imports. The strategy provides for the selection of a shortlist of importers eligible for incentives [37, pp. 68–71], and the ATDA official interviewed describes a decision-making process in which equipment is chosen on the basis of relations with supplier countries rather than of soils and crops. The same territorial official calls for a break with this logic: 'We must now say no, we are developing our own model in the light of our realities, in the light of our soils, in the light of our crops.'

The third mechanism relates to indicators. Those adopted for the access actions measure beneficiaries, budget consumption and increased demand, and the most advanced monitoring system, the geolocation of SoNaMA tractors, provides information on the hectares worked. The SNMA does include two indicators of use, the annual hours of tractor use and the share of machines idle for lack of repair that are brought back into service [37, pp. 72, 74], but both concern maintenance. No indicator covers implements that have been acquired but remain unused, access by category of farmer or the effects of mechanised practices on soils (Table A1 in the Appendix). A policy monitored with these indicators is poorly equipped to detect the gap relative to the ideal type, since that gap shows up largely in what is not measured.

Discussion:-

A gap relative to the ideal type concentrated on environmental dimensions:-

The scoring reveals a clear asymmetry: the SNMA contains operational instruments for the economic and organisational dimensions of agroecology, in particular shared use, but few or none for its environmental and agronomic dimensions, namely input reduction, soil conservation and diversified systems. This finding concerns the content of the policy, not its effects. The study did not measure soil compaction, erosion, organic carbon or any other soil property, and it does not show that the SNMA has caused soil degradation. The profile is consistent with the finding of Daum [8], for whom mechanisation contributes to sustainability only if coherent policies steer it towards compatible practices, and with that of Baudron et al. [21], who link appropriate mechanisation to conservation agriculture and private sector involvement. It also extends the observation made by Guyomard et al. [26] on the Common Agricultural Policy: stated environmental objectives have an effect only if the architecture of instruments makes them binding.

In the Beninese case, conservation agriculture is cited only as an example in the strategy's approach to implementing the subsidy, without any criterion that would make it enforceable. The ideal type thus makes it possible to locate the deficit, which lies less in a lack of intention than in the absence of instruments that translate

that intention into conditions of access.

Implementation as the stage at which the gap widens:-

The widening of the gap between texts and perceptions, from 8 to 12 points, is consistent with the value of comparing documentary analysis with appropriation by actors, although the perceived scores rest on an exploratory subset of interviews. Peeters and Campos [29] show that, in contexts of low administrative capacity, street-level agents reshape policies according to the resources available to them. The case studied offers an illustration: the territorial level, which according to the official interviewed did not take part in drawing up the strategy and learns of its orientations after the fact, defers to the national operator, whose action becomes the concrete form of the policy. This de facto delegation may explain why positive changes are attributed to SoNaMA rather than to the SNMA, and why the strategy's written commitments on equity were not mentioned by the actors interviewed. It echoes the analyses of Daum and Birner [17] on the governance challenges of mechanisation in Ghana, where the concentration of functions within public actors facilitated the capture of programmes.

Lock-in as a partial explanation for the persistence of the model:-

The three mechanisms identified correspond to the forms of path dependency described by Goldstein et al. [30]: inherited infrastructure and organisations, economic interests built around a supply channel, and measurement routines that render alternatives invisible. Their combination helps explain why a strategy that explicitly breaks with past failures nevertheless retains the core of its model, that of imported motorised equipment acquired individually. This finding qualifies the opposition often drawn between distribution policies and systemic policies [5], [22]. The SNMA includes genuine systemic components, namely shared use, training and research, but their scope is limited by financial instruments and indicators that remain those of distribution. The lesson echoes that drawn by the OECD from the Common Agricultural Policy: without action on lock-in mechanisms, reforms produce only incremental progress [35].

Alternative and complementary explanations:-

Lock-in is not the only factor that sustains this model. Some explanations are economic. Equipment suited to conservation practices, such as direct seeders, requires investment that small farms cannot finance without credit, and the SNMA itself identifies access to credit as one of the major constraints on agricultural development in Benin [37, p. 60]. Imported tractors, by contrast, are available through established supply channels, whereas the domestic manufacture of pre-harvest equipment remains limited [37, p. 34]. Other explanations relate to demand and farm structure. Part of the demand for tractors may express farmers' own preferences for land preparation [22], and mechanised tillage is concentrated in the cotton-growing north [40], where larger holdings favour equipment sized for large plots. Maintenance also matters: the scarcity of spare parts and after-sales services, noted in the SNMA [37, pp. 34, 69], makes a standardised range easier to support than a diversified one. Finally, the government's objective of rapid mechanisation, expressed in the 2030 vision of 'sufficient' mechanisation [37, p. 54], favours instruments that deliver visible results quickly, such as the distribution of tractors. These factors are less alternatives to lock-in than conditions that reinforce it: they make the inherited model economically and politically convenient, while lock-in mechanisms make departures from it institutionally costly. The data collected do not allow their respective weight to be assessed, which would require farm-level data on demand and costs.

Methodological contribution:-

The combined application of the ideal type and the policy mix framework offers two advantages for the analysis of agricultural policies. First, it makes the notion of coherence assessable, dimension by dimension, with ordinal scores that do not claim a degree of quantification that qualitative data do not allow, in keeping with the heuristic use of the ideal type advocated by Swedberg [34] and by Mulé and Walzenbach [33]. Second, it distinguishes the design gap, visible in the texts, from the implementation gap, visible in practices, which makes it possible to address differentiated recommendations to designers and to operators. The seven-dimension grid can be applied to other mechanisation policies in the subregion, provided that its construction and scoring rules are applied as specified in Section 2 and each score is documented with a verifiable excerpt, as in Table 5.

Limitations of the study:-

Several limitations circumscribe the scope of these results. First, the perceived scores rest on an exploratory subset of the interview material, consisting of two fully transcribed in-depth interviews, a further interview and workshop testimonies, and several observations rely mainly on the testimony of a single territorial official; they will need to be consolidated by coding the full interview corpus. Second, purposive sampling may have favoured actors who are more engaged with, or more critical of, the national policy, and since the interviews were conducted in French, the

excerpts quoted are the authors' translations. Third, ordinal scoring involves researcher judgement.

It was carried out by one author and checked by the co-authors, but without independent double coding or an intercoder agreement coefficient, and the ideal-type grid has not been validated by an external panel. Fourth, budget amounts are those of programming and not of execution, on which the documents consulted provide no information, and the subsidy and credit envelope referred to the FNDA could not be examined, although it largely determines the type of equipment acquired. Fifth, the policy documents span two decades and were not drafted at the same time; the SNMA, for instance, predates the SNDAEB, which limits the coherence that could be expected between them. Sixth, the study assesses policy content and perceptions, not environmental outcomes, and cannot establish the effects of the SNMA on soils. Finally, the analysis concerns a single national case, and its results cannot be generalised to other countries without applying the grid to them. The position of one of the authors within the PDA 2 innovation platform, and the precautions taken to manage it, are described in Section 2.

Conclusion:-

This study sought to determine the extent to which Benin's policy and institutional framework is consistent with mechanisation compatible with the agroecological transition. Assessed against a seven-dimension ideal type, the SNMA 2022-2026 reaches 6 points out of 14 in its texts, and an exploratory reading of the in-depth interviews gives 2 points out of 14 for its implementation. The strategy contains operational instruments for the shared use of equipment but none that make input reduction, soil conservation or adaptation to diversified systems operational. The interviews suggest that the gap widens during implementation, where actors describe a model centred on individual ownership of imported tractors, designed with little input from practitioners and communicated from the top down. The lineage of the national operator, an import-based supply chain and distribution-oriented indicators help explain the persistence of this model, alongside economic and structural factors such as the cost of alternative equipment, the availability of imports and the weakness of maintenance services.

Three implications follow for public action; Table 7 links each of them to the finding on which it rests, to the actors who could carry it and to an indicator for monitoring it. The first is to attach environmental and agronomic eligibility criteria to credit and subsidy instruments, for example by reserving part of the FNDA envelope for direct seeding, biomass management and reduced tillage equipment. The second is to supplement distribution indicators with indicators of actual use, of access disaggregated by category of farmer and of effects on soils. The third is to formally involve artisans, mechanics, CUMA and farmers in defining the content of equipment kits, through territorial consultation bodies with a recognised mandate. Two avenues for further research emerge: coding the full interview corpus and the budget execution of the strategy, and applying the grid to other national mechanisation policies in West Africa in order to establish whether the profile observed in Benin is a particular case or a regional configuration.

Table 7: Policy recommendations linked to the findings

Identified problem	Evidence	Proposed policy response	Responsible actors	Suggested indicator
No environmental or agronomic condition attached to credit and subsidies (D1, D5)	Actions 1.1.1 and 1.1.2 contain no eligibility criterion; the subsidy envelope is managed outside the SNMA (Tables 4 and 5)	Attach environmental and agronomic eligibility criteria; reserve part of the FNDA envelope for direct seeding, biomass management and reduced tillage equipment	MAEP, FNDA, with SoNaMA and financial institutions	Share of the subsidy and credit envelope allocated to equipment meeting the criteria
Monitoring limited to distribution and maintenance (D1, D5, D7)	Indicators on beneficiaries, budget consumption and demand; none on unused implements, access by category or soils (Table 6; Table A1)	Supplement distribution indicators with indicators of actual use, access by farmer category and soil effects	DGR (monitoring and evaluation), ATDA, SoNaMA (geolocation data)	Utilisation rate of implements; share of beneficiaries who are women, young people or smallholders; soil indicators on monitored plots
Equipment kits defined without	Strategy described as 'intellectualised';	Formally involve artisans, mechanics, CUMA and	MAEP, ATDA, SoNaMA,	Number of kit specifications

Identified problem	Evidence	Proposed policy response	Responsible actors	Suggested indicator
practitioners (D2, D3, D4)	unsuitable ploughs reported at the February 2025 workshop; ad hoc relations with manufacturers and CUMA	farmers in defining kit content through territorial consultation bodies with a recognised mandate	innovation platforms	revised after territorial consultation; participation of each category in consultation bodies

Source: authors, based on the results of this study.

APPENDIX:-

Table A1 lists the 50 indicators of the fourteen action sheets of the SNMA and classifies them according to the categories suggested by the reviewer. Access accounts for 4 indicators, distribution for 4, utilisation for 3, productivity for 1 and technical sustainability for 1; environmental effects and social inclusion account for none. The remaining indicators concern organisational and institutional arrangements (14), service quality (3), finance (1) and research and training outputs (19).

Table A1: Indicators of the SNMA 2022-2026 by action, classified by category

Action [page in 37]	Indicator (authors' translation)	Category	Informs an ideal-type dimension?
1.1.1 Credit [p. 61]	Percentage of beneficiaries who received credit	Access	No (not disaggregated)
1.1.1 Credit [p. 61]	Amount of credit allocated to agriculture by the financial system	Access	No
1.1.2 Subsidy [p. 63]	Percentage of farmers who received a subsidy	Access	No (not disaggregated)
1.1.2 Subsidy [p. 63]	Rate of consumption of the budget allocated to the subsidy	Distribution	No
1.2.1 CUMA [p. 64]	Number of new cooperatives created	Organisational	D6 (structures created, not use)
1.2.1 CUMA [p. 64]	100% of cooperatives have a reliable management system	Organisational	D6 (indirect)
1.2.1 CUMA [p. 64]	Number of cooperatives that have digitalised their management	Organisational	No
1.2.2 Hire services [p. 66]	Number of service provider enterprises created	Organisational	D6 (structures created, not use)
1.2.2 Hire services [p. 66]	Updated register of service providers and their fields of activity	Organisational	No
1.2.2 Hire services [p. 66]	Apex organisation of mechanisation service providers created and functional	Organisational	D6 (indirect)
1.2.2 Hire services [p. 66]	Beneficiaries' satisfaction with services above 90%	Service quality	No
1.3.1 Imports [p. 69]	Laws and implementing decrees drafted, adopted and disseminated	Institutional	No
1.3.1 Imports [p. 69]	Association of agricultural equipment importers created, functional and promoted	Organisational	No
1.3.1 Imports [p. 69]	Demand for agricultural equipment increased by 50%	Distribution	No
1.3.1 Imports [p. 69]	Private investment in the sector increased by 60%	Distribution	No
1.3.2 Local manufacturing [p. 71]	Volume of sales of locally manufactured equipment	Distribution	D2 (indirect)
1.3.2 Local manufacturing [p. 71]	Amount of credit allocated to local manufacturers	Access (supply side)	D2 (indirect)
1.3.2 Local manufacturing [p. 71]	Apex organisation of local manufacturers created and functional	Organisational	No

Action [page in 37]	Indicator (authors' translation)	Category	Informs an ideal-type dimension?
1.3.3 Maintenance [p. 72]	Service life of agricultural equipment significantly increased	Sustainability (technical)	No
1.3.3 Maintenance [p. 72]	Annual hours of tractor use increased steadily	Utilisation	No (tractors only)
1.3.3 Maintenance [p. 72]	Annual equipment output increased by 30 to 40%	Productivity	No
1.3.3 Maintenance [p. 72]	Users' complaints about maintenance and repair	Service quality	No
1.3.3 Maintenance [p. 72]	Network of private maintenance technicians functional and supported by the State	Organisational	No
1.3.4 Idle assets [p. 74]	At least 80% of machines idle for lack of repair are functional	Utilisation	No (repair only)
1.3.4 Idle assets [p. 74]	Network of maintenance technicians approved by SoNaMA created and functional	Organisational	No
1.3.4 Idle assets [p. 74]	100% of beneficiaries satisfied with after-sales service	Service quality	No
1.3.4 Idle assets [p. 74]	Repayment rate of equipment credit instalments increased by at least 70%	Financial	No
2.1.1 R&D crops [p. 76]	Number of machine prototypes developed	Research and training outputs	D3 (indirect; no co-design criterion)
2.1.1 R&D crops [p. 76]	Number of scientific publications on agricultural mechanisation	Research and training outputs	No
2.1.1 R&D crops [p. 76]	Number of PhD and Master's graduates or engineers trained in mechanisation	Research and training outputs	No
2.1.1 R&D crops [p. 76]	Number of technical sheets for agricultural advisory services	Research and training outputs	No
2.1.2 R&D livestock [pp. 77-78]	Number of machine prototypes and feed formulas developed	Research and training outputs	No
2.1.2 R&D livestock [p. 78]	Number of scientific publications on livestock mechanisation and new feeds	Research and training outputs	No
2.1.2 R&D livestock [p. 78]	Number of PhD and Master's graduates or engineers trained in animal production	Research and training outputs	No
2.1.2 R&D livestock [p. 78]	Number of technical sheets for agricultural advisory services	Research and training outputs	No
2.1.3 R&D fisheries [pp. 79-80]	Number of machine prototypes and fish feed formulas developed	Research and training outputs	No
2.1.3 R&D fisheries [p. 79]	Number of scientific publications on fisheries mechanisation and new fish feeds	Research and training outputs	No
2.1.3 R&D fisheries [p. 80]	Number of PhD and Master's graduates or engineers trained in mechanisation	Research and training outputs	No
2.1.3 R&D fisheries [p. 80]	Number of technical sheets for extension	Research and training outputs	No
2.1.4 Advisory programme [p. 81]	Validated modular extension programme on mechanisation available	Organisational	No
2.1.4 Advisory programme [p. 81]	Number of advisers specialised in agricultural and fisheries equipment trained	Research and training outputs	No
2.1.4 Advisory programme [p. 81]	Number of new practices adopted	Utilisation (adoption)	Unspecified (practices not defined)
2.2.1 Training programmes [p. 83]	Validated programme documents available	Organisational	No
2.2.1 Training programmes [p. 83]	Number of people trained at vocational level	Research and training outputs	No

Action [page in 37]	Indicator (authors' translation)	Category	Informs an ideal-type dimension?
2.2.1 Training programmes [p. 83]	Number of students trained at university level	Research and training outputs	No
2.2.2 Training institutions [p. 84]	Number of students trained at vocational level	Research and training outputs	No
2.2.2 Training institutions [p. 84]	Number of students trained at university level	Research and training outputs	No
2.2.2 Training institutions [p. 84]	Number of beneficiaries of qualifying training	Research and training outputs	No
2.2.2 Training institutions [p. 84]	Number of scholarships awarded	Research and training outputs	No
2.2.2 Training institutions [p. 84]	Number of partnership agreements signed	Organisational	No

Source: action sheets of the SNMA 2022-2026 [37, pp. 60–84]; classification by the authors.

Acknowledgements:-

The authors thank the MecaWAT project, funded by the French Agricultural Research Centre for International Development (CIRAD), whose support made it possible to build the database on which this research draws.

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