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D2.1 : Light case study and in depth case study reports of identified cases; including a synthetic cross analysis report

Abstract: This report is a first synthesis report of the In-depth Case Studies (IDCS) and Light Case Studies (LCS) implemented under the umbrella of WP2 of the PROIntensAfrica project. In parallel with a literature review, case studies have been implemented in order to document agricultural intensification dynamics in Sub-Saharan Africa. This report consists of a general description of the selected case studies, and a preliminary cross case study analysis.

In a separate google drive file, the executive summaries of all case studies are provided. The drive also presents the raw full reports of of all the CS. It can be accessed with the link https://drive.google.com/open?id=0Bz1YBNqX1eprV3ZsbzA2Ql8zTTg The document explores different research themes which have been explored in the case studies, and suggests a classification with the 5 following components : Production, Households, Landscape, Food system and Public Policies. Indicators are also considered, and some convincing examples are presented. The drivers of changes have been carefully analysed in every case study, and a tentative synthesis is presented, considering four families of drivers : Macro drivers, Local drivers, Households drivers and Biophysical drivers. The document concludes with general remarks on sustainable intensification, and presents the perspectives of linking the CS analysis with the literature review, from which a research and Innovation Agenda will be derived.

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Preface

This report provides the first synthesis of the In-depth Case Studies (IDCS) and Light Case Studies (LCS) implemented under the umbrella of WP2 of the PROIntensAfrica project.
This report consists of a number of sections, including the methodological section, a general description of the case studies, and a first and preliminary cross case study analysis. This report is part of the overall deliverable 2.3, as the individual case study reports are part of it. These case study reports are made available, together with this report.
The Synthesis part of the report is preliminary first step, as the time between submission of the individual case study reports to the WP2 coordinating team and the deadline to submit Del 2.3 was too short for in-depth analysis. The 17 case studies yielded a wealth of information, which will be analysed more in-depth after submission of Del 2.3. Results will be included in Del 2.4 and the final outcome of the PROIntensAfrica project, the vision document for the future strategic Africa-Europe research and innovation partnership on sustainable intensification of the food systems in Africa.

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1. Synthesis

1.1. In-Depth and Light Case Studies: rationale and description.

Origin

In parallel with a literature review, case studies have been developed for documenting agricultural intensification. On the one hand the ex-post analysis by multi-disciplinary scientific teams of the rationale, the drivers, the components and the effects of intensification processes underway within such transformation. On the other hand the appraisal through dialogues with key informants and concerned stakeholders of their perception of the transformation and intensification processes within.

- Case studies are expected to test to what extent hypotheses about intensification pathways and their effects and outcomes derived from the first stages of the literature review are relevant. Those studies may also identify new evidences, document intensification dynamics at play and the adaptation/ adoption dynamics by farmers and other stakeholders. It will document controversies.
- In order to cross scientific '*evidences'* (as provided by literature review or experts views), and the *'unknown knows' (*knowledge from stakeholder in the considered situations) the case studies aim at gathering view-points from scientists and from the diverse categories of stakeholders. Outputs, impacts and outcomes from on-going transformation in agriculture have been analyzed.
- Case studies should also contribute to better describing the role of key stakeholders involved in Intensification pathways as well as their decision making determinants.

Two categories of case studies have been implemented:

• Six **In-Depth Case Studies** (IDCS) have been implemented, focusing on important domains in relevant socio-economic and biophysical conditions to document intensification pathways in agriculture in Sub-Sahara Africa. IDCS will analyse existing documentation, collect a relevant set of data for a diagnosis of the on-going changes, effects and outcomes. In addition, IDCS organise semi-structured surveys and focus group discussions with a large array of R&I stakeholders (including farmers and their organizations, research and extension services, entrepreneurs, NGOs, local, regional and national government officials, financial entities, etc.) From the diversity of stakeholders involved in the case studied, a multi-stakeholder panel has been installed with the responsibility to contribute to the assessment of the considered Intensification pathways and to draw lessons from the results obtained.

• 11 **Light Case Studies** are implemented to cover thematic diversity occurring in sub-Sahara Africa which is not covered by the IDCS. Most of the additional assessments on the intensification pathways are conducted for every light case study through participatory workshops (individual and group interviews in the field with representatives of key stakeholders) and through analyzing existing sources of information (including 'grey' literature not available or accessible under Task 2.1).

1.2. Selection

The IDCS have been selected during a WP2 workshop, organized in Brussels in July 2015. The WP2 leaders had prepared a list of criteria, and 15 "Candidate Case Studies" have been presented to the group by their authors (or their defenders) After the presentations, all participants contributed to the scoring of all ideas presented, to end up with the selection of four

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IDCS. After the workshop, the addition of two additional IDCS was made possible thanks to extra funds provided by CIRAD and IRD.

Table 1 : Presentation of the In Depth Case Studies

No	Title	Country	Lead ProIA Consortium member	Partners
1	Sustainable Intensification of mixed farming systems/local value chains (maize, cattle, small ruminants, cotton ...)	Burkina Faso, (Côte d'Ivoire, Mali)	INERA	CIRDES and, UPGC (in Côte d'Ivoire) and IER (in Mali), CIRAD
2	Putting Nitrogen fixation to work for smallholder farmers in Africa	Ghana, Kenya	Wageningen UR	IITA, Kari, WeRATE, local govnts. (Kenya); CRI-SARI, CRS, IFDC and URBANET… (Ghana)
3	Sustainable intensification in the Cocoa area	Cameroon	CORAF/WECARD	IRAD and CIRAD
4	Sustainable intensification in the Highland rice production area	Madagascar	CIRAD	FOFIFA and Univ. of Madagascar
5	Towards Agricultural intensification in the Senegal groundnut basin	Senegal	IRD	ISRA, Univ. of Dakar
6	Intensive dairy and irrigated crops in Senegal River delta	Senegal	CIRAD	ISRA, CORAF/WECARD, Univ. of Dakar, ILRI

A call for LCS was launched in December 2015. The selection of the LCS has been operated by WP2 leaders In the table below, the **11 LCS** selected are summarized.

Table 2: Presentation of the Light Case studies

No	Title	Country	Lead ProIA Consortium member	Partners
1	Community Led Potato Seed Production, Multiplication and Distribution	Eritrea	TEAGASC	NARI, Vita
2	Preservation and increase of soil organic carbon content	Kenya	Szent Istvan University	KARI
3	Scalable Sustainable Intensification Pathways for Rainfed N-deprived Maize-Legume Cropping Systems	Mozambique, Tanzania, Eastern and Southern Africa	ARC, ISA-ULisboa	NARS, CIMMYT
4	Improving dairy genetics and herd management in Senegal – Food Africa	Senegal	LUKE	EISMV, ILRI, University of Helsinki
5	Sustainable Intensification pathways for dairy farming in Kenya	Kenya	Wageningen UR	Egerton University
6	Learning from Triple L Research Initiative	Kenya	SLU	Univ. of Nairobi
7	Consortium for improving agriculture-based livelihoods in Central Africa	Burundi, Rwanda, Uganda, RDC	UCL	ASARECA, IITA, Biodiversity, NARS
8	Sustainable intensification in the horticulture value chain – a study of constraints and potentials	Ethiopia	ZEF	NutriHAF project, GlobalHort network
9	Agricultural intensification	Mali, Sudan	NIBIO	IER (Mali), DRC, ARC,

	through improved soil fertility management and mechanization			and ElObeid (Sudan)
10	Organic farming in East Africa	Kenya, Uganda, Tanzania	UCPH	Uni. Of Nairobi, Makerere Univ., Sokoine Univ., ICROFS
11	Linking farmers to markets - intensification through certified organic production	Uganda	BOKU	Go Organic, Makerere Univ., NOGAMU

1.3. Managing the case studies

The activities implemented in the case studies have been developed according to guidelines which have been elaborated by WP2 during methodological WP2 meetings, and later shared among the participants. Every CS has adapted these guidelines according to its specificity.
The main activities (common to IDCS and LCS) were:

- *Local literature review (including grey literature)*
- *Identification and enrolment of members for the expected stakeholder panel,*
- *Identification of apparent drivers of changes and intensification processes, selection / adaptation / reformulation*
- *Field work to collect information*
- *Brainstorming sessions to identify and justify priority topics and/or areas of future research*
- *Implementation of case study report according to common structure*

For IDCS only: preparing the synthesis and stakeholder panel

- *For every identified case study, a specific stakeholders group has been organized under the responsibility of the two CS co-leaders with the mandate to lead the group.*
- *The meeting aimed at discussing all findings related to the corresponding case study, to identify convergences or controversies among participants on the main Pro-IA issues*

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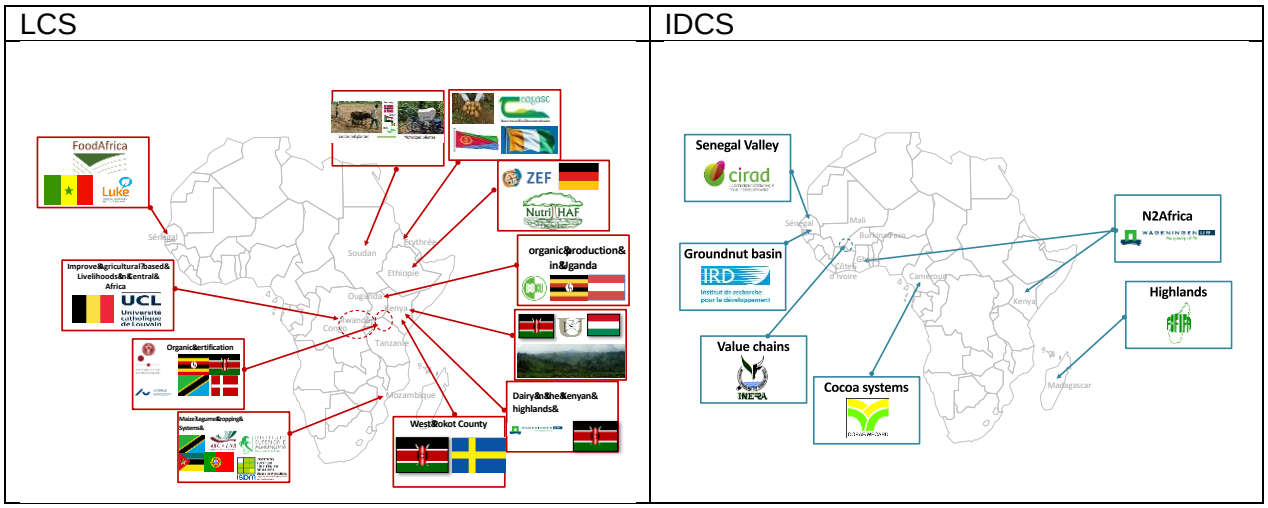
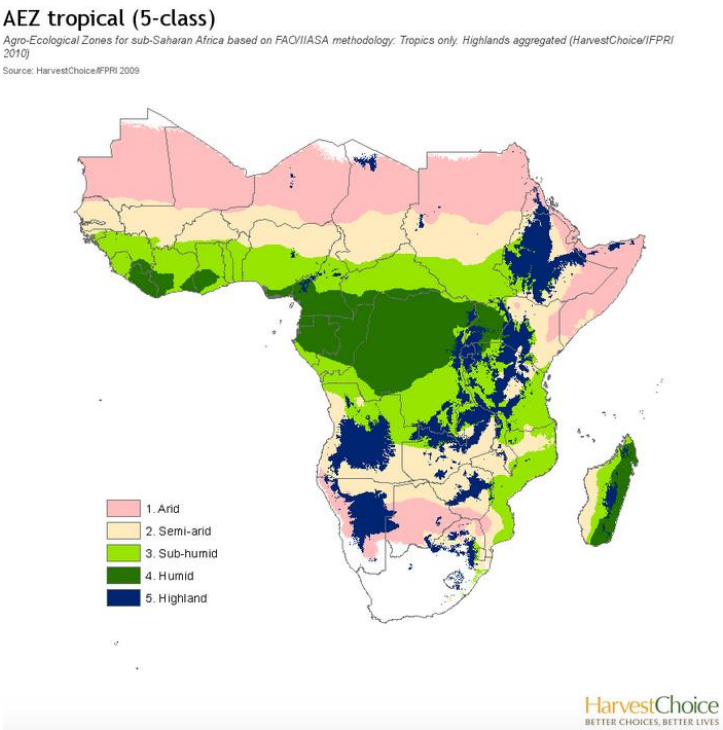
1.4. Representativeness (IDCS / LCS)

The maps below present the geographical distribution of the case studies[1].
Maps and flags plotting IDCS and LCS.





1.4.1. Geographic / Agroecological representativeness

The IFPRI/FAO agroecological zoning of Africa identifies 5 main agroecological zones. The main agroecological regions of Sub Saharian Africa are covered by at least one CS. The

[1] For clearer maps, refer to the List of the ProIA case studies, available on the WP2 google drive.

selection of IDCS resulted in an over representation of Western Africa. To balance the agro-ecological representativeness, most of the LCS are selected in the Eastern part of Africa (see map above).

1.4.2. Institutions / partnership

The original planning was that all PROIntensAfrica partners would be involved in at least one of the case studies. After the selection of the IDCS and the LCS it turned out that a number of African consortium partners were not involved in the case study activities. Other African institutions were, however involved in the case studies. Regarding European partners of the PROIntensAfrica consortium, only two beneficiaries were not directly in a CS activity.
The purposes of the CS may be focused on regional development, on a specific commodity value chain, or on a specific intensification pathway. Among those options, the main commodity chains addressed by the CS are: Milk, livestock sugar cane, legumes, maize, cocoa, cotton, potatoes, rice, pearl millet, sorghum, peanut, horticultural products. The regional development was specifically addressed by the two Senegalese's IDCS. Specific agro environmental issues were addressed on Carbon and Nitrogen. In parallel, pure or specific organic agriculture situations were directly addressed by three LCS. For the IDCS, important roles were attributed to the various stakeholders involved in the intensification process in the study area. The main stakeholders and importance are given for each of the case studies in the table[2] below, assuming that at least one European and one African research center were involved. They actively participated in the stakeholder panel meetings, expressing cross cutting and sometimes unexpected points of view on the discussed issues.

Table 3: Relative weights of partners involved in the case studies

	National African Administration	NGOs and Farmers Organizations	Private sector	CGIAR Centers
IDCS1 (Burkina Faso)	**	***		*
IDCS2 (Ghana/Kenya)	*	**	*	**
IDCS3 (Cameroon)	**	***		*
IDCS4 (Madagascar)	***	***		
IDCS5 (Central Senegal)	**	***		
IDCS6 (Senegal Valley)	*	*	***	*
LCS1 (Eritrea)	*	***	**	
LCS2 (Mt. Kenya)	*	**	***	
LCS3 (Mozambique/Tanzania)	*	**		***
LCS4 (Senegal)	*	***	*	*
LCS5 (Kenya)	*	**	***	
LCS6 (Kenya West Pokot)				
LCS7 (Burundi/Rwanda/RDC)	*	**		***
LCS8 (Ethiopia)		****	**	
LCS9 (Mali/Sudan)		***	***	
LCS10 (Uganda/Kenya)	*	***	**	
LCS11 (Uganda)	**	**	**	

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1.4.3. Cropping systems and main problematics

FARA[3] identifies 14 main cropping systems in Africa, see the table below. Among these cropping systems, we consider that 10 of them are represented in the CS; however, the so called "Root and tubers", "Cereal root crop mixed" and "Fish based" systems are few (or not) represented. But the biggest lack in our sample is "irrigated systems". As a matter of fact, even if the area under irrigation in Africa represents less than 5% of the cultivated area, it represents more than 20% of the agricultural production, and irrigation represents a high potential of growing. In addition, the pessimistic climate change perspectives for SSA will evidently have, as a consequence, a higher pressure on water resources and on their appropriate and sustainable use. A special effort on irrigation will thus be needed in the final ProIA report, as it has no dedicated case study (in Senegal Valley, irrigation is not the main entry point) . Regarding the "fish based" cropping system, the problem is similar with the huge difference that the relative weight of these cropping systems remains low in the SSA context.
It was never the intention of PROIntensAfrica, however, to cover the wide variety of agro-ecological zones and main cropping systems identified. To cover this variability is too ambitious for a relatively small project with a lifespan of only two years. The case studies covered sufficiently the variability to understand better the sustainable intensifications options for building the research agenda for the future partnership.

1.4.4. Intensification pathways.

Four pathways had been pre-identified in the project: · the "high input pathway" (pathway 1), · the "sustainable intensive agriculture" pathway (pathway 2), the "agro-ecology pathway" (pathway 3) and · the "organic agriculture" pathway (pathway 4). Based on some difficulties, these pathways have later been adjusted and finally slightly reshaped. A new definition has been proposed in the annexes of the D2.1.

The pathways defined in the PROIntensAfrica framework have been built up in order to organize the project. They don't match perfectly any experienced intensification trajectory but are rather ideal construction based on identified agricultural sets of practices and principles.
It now appears clearly that the pathways identified in PROIntensAfrica reflect goals or strategic options rather than trajectories of change. Since those pathways are conceptual constructions, one should not ignore that they are implicitly linked with a broad political vision on development strategy. Moreover, the case studies that covered regional approaches showed that different pathways coexist in space and time, and that they might even interact.
The following table aims at describing the diversity, and summarizing the characteristics of the CS regarding the Farming systems / Ongoing intensification pathways / commodity chains addressed in the case studies. The classification has been initially realized by the WP2 leaders, and was submitted later on to the CS leaders for fine tuning.

Table 4: Classification of the case studies

[3] FARA Science Agenda for Agriculture in Africa, Accra 2014.

	Intensification pathways (1)	"FARA" cropping systems	Main Commodity chains, or Main issue addressed by the CS
IDCS1 (Burkina Faso)	1,**2**,3	1, 5, 12	Maize, meat, milk, small ruminants, cotton…
IDCS2 (Ghana/Kenya)	2,3	1, 2, 5	Grain Legumes
IDCS3 (Cameroon)	**2**,3	4,7, 10	Cocoa
IDCS4 (Madagascar)	1,**2**,3	2,6	Rice, Beans, Fodder, Ruminants, Fish
IDCS5 (Central Senegal)	2,**3**,4	2	Cereals, Oilseeds, Horticultural products and fruits, meat
IDCS6 (Senegal Valley)	1,**2**,3	13	Rice, cattle milk, sugar cane, vegetables.
LCS1 (Eritrea)	**2**, 1	6	Potatoes
LCS2 (Mt. Kenya)	**2**	3	Tea, Coffee, Banana, Corn, Tobacco
LCS3 (Mozambique/Tanzania)	**2**,3	1, 2	Legumes
LCS4 (Senegal)	**1**, 2	2, 8	Dairy cattle
LCS5 (Kenya)	**2**	1, 3, 6, 8, 14	Dairy
LCS6 (Kenya West Pokot)	1,**2**,3	2,6	*Enclosures*
LCS7 (Burundi/Rwanda/RDC)	**2**,3	3	Banana, cassava, legumes
LCS8 (Ethiopia)	**2**,3,4	3, 6	Fruits and vegetables
LCS9 (Mali/Sudan)	1,2,**3**	2	*Crop production and protection*
LCS10 (Uganda/Kenya)	**4**	5	Vegetables, Fruits, Dairy
LCS11 (Uganda)	**4**	6,12	Coffee, fresh and dried fruits, cotton, spices, fish

(1): In bold, the dominant pathway

1.5. Case studies report basic framework

Most of the full text reports can be accessed on
https://drive.google.com/open?id=0Bz1YBNqX1eprV3ZsbzA2Ql8zTTg
They are presented according to the following outline:

1. Context

Description of the area concerned: agro-ecological conditions and specializations, human concerns, main socio-economic indicators, main challenges and strengths.

2. Agrarian dynamics

The main agrarian dynamics in the last decades, including:

- Agrarian systems changes
- Households/Farms typologies including trajectories
- An idea of the most relevant drivers of change (including public policies)

3. Multistakeholders panel meetings: Debates and controversies (For IDCS only)

Main debates and discussions that took place during the stakeholders' panel meetings regarding intensification. What is identified as desirable future for farming? By whom (politics, farmers, NGOs…)? Which intensification trajectories are locally identified as the way forward? By whom? Confrontation results and points of views. Possible differ-

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ences/contradictions between results (from interviews and literature review) and discussions (ex. drivers identified, options for intensification…)
This item may be incorporated in the six full reports and may be reported in specific documents (IDCS 2 and 3). Films may be presented, role games, theatre as well IDCS 6)

4. Agriculture's intensification representations and realities

This part describes what is considered as sustainable intensification in the area/value chain, what is considered as a sustainability issue. This part presents the indicator approach (building, implementing), and addresses the pathways issues regarding observed sustainable intensification. Possible combinations of sustainable intensification options take place here.
This part considers the main obstacles or drivers for engaging in sustainable intensification processes

5. What knowledge gaps? What researches to enhance sustainable intensification?

All reports present a multiscale suggestion on research and innovation proposals, which should be aligned with the generic proposition which was suggested for the literature review main topics (See D2.3)

2. Cross cutting analysis

2.1. Exploration of different research themes

The case studies provide a wealth of information. Each case study focusses on specific aspects of a local production system (or local production systems) and offers different perspectives for research at different scales. Five different perspectives are distinguished. All of them also consider cost and benefits issues.

1) Production and productivity

The first research component explored by all the case studies is the production and the productivity issue. Even if it is not necessarily the main entry point, all case studies analysed agricultural intensification in terms of production dynamics at the production system level.
For example, they aim to observe changes within the following aspects:

- Characteristics of local production systems/units
- Agricultural practices
- Local bio-physical characteristics

2) Households situation/strategies

Several case studies address intensification using a households based perspective. At the farm level, intensification is the result of households' strategies and *vice versa* intensification dynamics impact households' livelihoods.
This scale highlights the transitions dynamics at the farm level and reveals the crucial role of socio-economic factors in sustainable intensification strategies.

3) Landscape and resources management

Some case studies observe intensification dynamics at the landscape level, exploring natural resources management strategies as well as interactions among the different actors of the local production system. This landscape perspective gives a wider picture of intensification

dynamics and requires to consider agricultural issues in a given socio-ecological environment.

4) Food systems and value chains

Food systems and values chains are another research theme explored by the case studies. Intensification dynamics linked with market and value chains are a great source of information to understand the trajectories at different levels, from the farm to national strategies.

5) Public policies

None of the case studies adopted public policies as an entry point to address intensification. However, the political issues are often considered as an important scale to observe in order to understand intensification dynamics and are, therefore, more or less explored in the final reports.
The table below proposes as entry points the primary and secondary themes for the different case studies.

Table 5: Research themes explored in the case studies

	Production	Households	Landscape	Food system	Public Policy
IDCS1 - Burkina Faso					
IDCS2 - Ghana/Kenya					
IDCS3 - Cameroon					
IDCS4 - Madagascar					
IDCS5 - Central Senegal					
IDCS6 - Senegal Valley					
LCS1 - Eritrea					
LCS2 - Mt. Kenya					
LCS3 - Mozambique/Tanzania					
LCS4 - Senegal					
LCS5 - Kenya					
LCS6 - Kenya West Pokot					
LCS7 - Burundi/Rwanda/RDC					
LCS8 - Ethiopia					
LCS9 - Mali/Sudan					
LCS10 - Uganda/Kenya					
LCS11 - Uganda					

First – **Second** – or **Third** entry points

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2.2. Exploration of Indicators

1) Rationale of indicators

Indicators are needed to realize an effective and comprehensive comparison between different pathways, to enable a multi-criteria assessment approach, and to identify relevant agronomic, social, ecological and economic indicators. This calls for an indicator-based analytical framework. Relevant researches exist, notably around life-cycle analysis, to catch sustainability in agriculture and food systems, but progress is needed. The PROIntensAfrica D2.4 will develop on this issue. These kind of analyzes have not been implemented in the PROIntensAfrica case studies. It was anticipated that relevant indicators should concern (i) effectiveness in increasing production while enhancing input and labour efficiencies, (ii) capacity to contribute to social and economic development of farmers and livelihoods improvements, (iii) capacity to maintain and support key ecosystems, and (iv) contribution of intensification dynamics to local/regional/national development or economic growth.

2) Fine tuning methodology to implement the indicators in the case studies

WP2 organized a workshop in Dakar with all IDCS and two LCS leaders, to agree on the indicators needed for case studie comparative analysis. The main questions in Dakar were: *Is it possible to unify criteria and indicators (some may make sense in a specific CS, but not in another*) *and if yes, how?* The group agreed on a framework along the following line: *principles => criteria => indicators.* The principles are common to all case studies, but criteria and indicators may be site-specific. Five principles were identified: *Productivity, Environment* (or eco-system services?), *Viability, Resilience, Social well-being*. The criteria and indicators should be explored per case study (to be defined locally).

3) Implementation

Even if ideas and concepts have been completely assimilated, the effective implementation of a unified methodology, including work on a set of common principles for all the case studies using spider diagrams, is challenging. Therefore WP2 proposed a more flexible and classical framework that will be used to unify (and eventually compare) the situations (see box). This allowed an indicator approach for all case studies, as described in the reports of each case study. The variability in indicators allows comparisons within case studies, but hampers comparisons between case studies. For example, the in-depth case study 2 allowed comparison between various locations in Kenya and Ghana (see annex). Another example concerns the in-depth case study 4 (Madagascar), where farms trajectories have been observed over time and were then compared with each other's and represented in multispectral spider diagrams.

2.3. Intensification – The drivers of changes

Intensification refers to a dynamic process. More precisely, intensification refers to a situation where a production factor – generally the limiting one - is improved, resulting in a better performance of other production factors. Intensification can be considered, therefore, as the result of an action in which some aspect of a system has been intensified, resulting in a rearrangement of production factors. In order to understand the dynamics of intensification, it is important to know its origin and its drivers. Any change in the availability of production factors may become drivers of change and impact intensification at different levels. The case studies all intended to identify the drivers of local intensification dynamics. Based on the reports from case-studies, four families of drivers corresponding to four levels of change were observed:

drivers at macro level, drivers at local level (community/ territory), drivers at the household level and (biophysical) drivers at the field level.

1) The macro changes/trends

The first and largest level of changes identified in the case studies is what we call here the "macro level", which refers to endogenous and exogenous global changes/trends that impact farming systems. The main driver of change referred to in the case studies is population growth and its diverse effects on farming systems. Population growth induces market changes by increasing demands. Population growth also increases land pressure and raises land availability issues that positively or negatively may impact intensification processes. Often mentioned in linkage with demographic change is urbanization and the growth of the middle class, which also induce market changes with the upcoming new specific markets like animal derived products markets for example. Climate change is often identified as an important exogenous driver. It forces producers and local authorities to adapt their strategy to maintain productivity in a profitable way.
Those macro drivers are endogenous and exogenous trends that also induce changes at all the others following scales and influence more local drivers. For example, population growth increased local population density and encouraged people to migrate or diversify their activity. The typology presented here acknowledges those interactions between local and global changes.

2) "Local drivers" - community/territory based changes

Several local changes have been identified as drivers of change in the case studies. Access to input and output markets, factor markets (labour, land, capital, technology) as well as the development of local infrastructures (roads, market buildings, transformations and storage facilities…), impact intensification positively. These drivers of changes sometimes induce other changes that can be considered as indirect drivers of intensification: better market access may lead to a higher uptake of technology. Local policies as well as the presence of development projects may also drive changes at the local level.

3) Households' based changes

Several changes at the households level might also impact the farming system and become drivers of intensification. The households' economic situation is a strong explaining factor of intensification at the farm level. Access to land and technology, for example, have a strong impact on the adoption of new agricultural practices. Land scarcity is identified in the case studies as an important driver of intensification. The farm size positively induces a capacity to generate higher self-financing capacities. Also other household characteristics such as the household size, i.e, the amount of manpower, is a strong driver of intensification because it can influence the adoption of labour intensive practices. For example, in the areas studied in Mozambique and Tanzania in LCS3, larger households are more likely to adopt use of animal manure than smaller households.
The households' income may also be a driver of change towards intensification. Non-agricultural income might therefore stimulate changes in the farm trajectory. The case study in Madagascar (IDCS5) showed that intensification depends on the relative availability of the different production factors (manpower, capital, land, livestock…).

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4) Biophysical drivers

Also biophysical characteristics are possible drivers of change. Soil erosion, water pollution or soil fertility induces changes in the agricultural practices and in the overall farming system. The table below presents the relative weight of the identified groups of drivers for each case study. The number of stars aims to represent the degree of importance.

Table 6: Relative importance of the drivers identified in the case studies

	Macro drivers	Local drivers	Households	Biophysical
IDCS1 - Burkina Faso	**	****	-	-
IDCS2 - Ghana/Kenya	***	**	-	*
IDCS3 - Cameroon	*	**	***	-
IDCS4 - Madagascar	*	-	****	*
IDCS5 - Central Senegal	**	*	*	**
IDCS6 - Senegal Valley	***	***	-	-
LCS1 - Eritrea	***	***	-	-
LCS2 - Mt. Kenya				
LCS3 - Mozambique/Tanzania	*	**	***	-
LCS4 - Senegal	***	**	-	*
LCS5 - Kenya	**	-	-	****
LCS6 - Kenya West Pokot				
LCS7 - Burundi/Rwanda/RDC				
LCS8 - Ethiopia	****	**	-	-
LCS9 - Mali/Sudan	-	**	*	***
LCS10 - Uganda/Kenya	*	**	***	-
LCS11 - Uganda	***	**	-	*

2.4. General remarks on sustainable intensification from ProIA CS lessons

Research analyzed in all PROIntensAfrica case studies (CS) mainly targets research at plant, animal or plot level, more rarely addressing the household level and downstream production segments of food systems. Beyond ProIA CS, holistic and global approaches remain rare in African Agronomical research. When researches address food systems, it's mainly through agrifood chains approaches, focusing on one product (or on an homogenous group of products). These value chains studies are almost vertical, tackling economical regulation of upstream and downstream segments of the chains.

In ProIA CSs, as in most of the scientific literature, agriculture intensification remains an "in field" production and productivity issue, or "along the value chain" approaches, with a main concern on creation and sharing out added value. Therefore, sustainability is addressed mainly from a technical angle, with a focus on natural resources management issues. Social aspects are mainly caught through natural assets access competition, or through the nature of the actors' interactions within a specific value chain. Livelihood approaches remain partial and are rarely extended to the global agriculture's models and food systems.

What are the first lessons learnt from the ProIA CSs? We propose below a list of items, to be discussed and confirmed by the literature review (upcoming D2.4) .

- The advantages and disadvantages of the high input pathway (pathway 1) are obvious. In large parts of the world this pathway resulted in strong increases in land and labor productivity. In large parts of Sub-Saharan Africa, however, efforts to improve the productivity using this pathway resulted in limited production increases, much lower than the potential production. One of the disadvantages of the high input pathway is the negative effects on the natural resource base.
- The case studies also show concern about the future, with environmental threats combined with alerts on food and nutrition security: the loss of soil fertility (with the great challenge of erosion) and the multiple vulnerabilities of production and food systems (with a focus on biodiversity and weeds quality, land and other natural resources access, plant protection and human health), lead to a need for conceiving convincing alternatives.
- Some scattered success in terms of yield increase and market integration are identified and analyzed. Most CSs mention promising options, but the analysis is almost always accompanied by more pessimistic considerations about the sustainability of the considered success, the ruptures introduced by projects temporality ad short terms perspectives, and the need for action to address sustainability as well.
- Similarly, traditional systems (which may be hybridized with agroecological options) appear to be resistant, well adapted to local ecosystems and resilient, but also demonstrate their difficulties in addressing demographic and employment challenges, climate change and food security in all its dimensions.
- The case studies finally show the fragility, and somehow the ambiguity, of alternative solutions proposed by researchers and extension services. Most of the studies argue for a greater use of traditional factors of intensification (genetic engineering, mineral inputs, mechanization, accompanied by credits, collective action, etc.), and for a modernization of production structures, inspired by structural transformation that occurred in todays developed countries. But, at the same time, they highlight the difficulties of this shift and its weak compatibility with the need for environmental sustainability. The tendency is, therefore, a critical evaluation of pathway 1 and a need for a shift towards pathway 2, but with a pessimistic view of the possibility to access the necessary means to achieve it.

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- In addition, the CSs seem to demonstrate that, at local scale and analysis, different pathways may coexist. Farmers may switch towards a pathway and come back. They may also share their farms and manage it along two parallel options. Farmers, or even villages may change options in time (for example adopting and then neglecting Conservation Agriculture).
- Current trends of research funding, especially public funding, start to change from a dominantly research funding for the high input pathways, to a slightly more divers agenda, including also the more “ecology based” pathways (Agroecology and Organic pathways) and the intermediates (Sustainable Intensification pathway). It is concluded from some of the case studies that especially for the organic pathway very specific research questions have to be addressed, e.g. pest and disease control and integrated nutrient management, taking into account the local settings and conditions of the production system.

Cross-analysis of CSs refer, explicitly or implicitly, to recurrent constraints of agriculture intensification (natural resources availability, soil erosion and low fertility, access to inputs, credits, recent innovations and public good, etc.) and to the difficulties, in this context, of thinking and building credible alternatives. And, indeed, the reflections that emerge in the borders of agricultural science (ecology, nutrition, food processing, social justice, territorial development, etc.) should be interesting paths to imagine innovative alternatives.
Farming and food systems reality is diverse, trajectories are non-linear and results from multiple external or internal forces. Inflections in research orientations are at work to catch this complexity and to go beyond dead-ends of segmented specialized approaches. Looking at farming dynamics, including technical and social dimensions (Madagascar, Western Kenya, Ghana or West African Savannah), and paying attention to "territory" and agricultural models coexistence (Senegal delta), indeed demonstrates the interest to analyze agriculture intensification through interactions between components often studied in isolation in the process of farming transformation. A need appears to address challenging issues from the plant to the plate, with particular attention, among fertility, labour and land productivity, to household strategies and behaviours, on- and off-farms co-conception of innovations in production as well as in processing, corporate dynamics and public policies orientations.
In many other CSs the focus on environmental issues requires expansion of the fields of study and to change our perceptions of intensification. Intensification is no longer only related to artificialization and massive use of mineral inputs, it now incorporates local ecosystems processes and knowledge articulated with local and external scientific knowledge. Therefore, performance can’t be strictly measured by the usual indicators of the intensification (yields and labor economical productivity); research has to fix an innovative set of multicriteria indicators to catch sustainability all along the food systems.
We also see through the reflection on organic farming that food systems dynamics can be socially driven. This requires formalizing the balance of power that contributes, alongside the technical and economic issues, to drawing the pathways of intensification. In the same vein, proIA CSs show that public policies are still levers for transforming food systems with potential great impacts on agriculture intensification.

Case studies have brought a very diversified set of information regarding various African situations (cropping systems, commodity chains, problematics, agroecological zones etc.). This preliminary cross analysis is already giving a wide cover of the diversity of what is happening actually in Africa on Intensification issues, and gives some ideas of how Research and Innovation systems could accompany these processes. Considering the global ambitions of ProIA, the CS are providing actual situations against which the theoretical Research and Innovations agenda that will be proposed should make sense. A fruitful dialogue will be thus established between ideas and concept provided by Literature Review and the mirror provided by the 17 CSs.

3. ANNEXES

Annex 1 : Summary characteristics of the 14 major sub-Saharan farming systems (FARA 2013)

Farming Systems	Defining characteristics	Mean LGP	Market access	Main livelihood source	% Sub-Saharan rural poor <$1.25/day
Maize Mixed (1)	Sub-humid and humid areas, dominated by maize with legumes	191	Medium	Maize, tobacco, cotton, cattle, goats, poultry, off-farm work	19.9
Agro-Pastoral (2)	Semi-arid areas, mixed sorghum/millet and livestock systems	129	Medium-high	Sorghum, pearl millet, pulses, sesame, cattle, sheep, goats, poultry, off-farm work	17.3
Highland Perennial (3)	Moist highland areas with a dominant perennial crop either banana (often with coffee) or enset in Ethiopia	267	Medium-high	Banana, coffee, roots, tubers, beans, cereals, livestock, poultry, off-farm work	15.0
Root and Tuber Crop (4)	Lowlands, dominated by roots and tubers with no major tree crop,	271	Medium	Yams, cassava, legumes, off-farm work	10.9
Cereal-Root Crop Mixed (5)	Two starchy staples alongside roots and tubers	186	Medium-high	Maize, sorghum, millet, cassava, yams, legumes, cattle, off-farm work	9.3
Highland Mixed (6)	Above 1700 m; LGP, temperate cereals due to altitude	193	Medium	Wheat barley, grain legumes, rape, potatoes, live-stock, poultry, off-farm work	8.1
Humid Lowland Tree Crop (7)	Where tree crops replaced forest; > 25% source of cash income; Oil palm has local market	292	High	Cocoa, coffee, oil palm, rubber, citrus, yams, cassava, maize, off-farm work	6.5
Pastoral (8)	Household income from extensive livestock production	70	Medium	Cattle, camels, sheep, goats, remittances	4.5
Fish-Based (9)	Proximity to sea or lake; fish is significant livelihood source	194	High	Fish, coconuts, cashew, banana, yams, fruit, goats, poultry, off-farm work	3.5
Forest-Based (10)	Humid lowland heavily forested areas	343	Low	Subsistence food crops roots and tubers, maize, beans, and off-farm work.	2.5
Irrigated (11)	Large scale irrigation scheme; mappable; absence of rainfed agriculture	53	High	Rice, cotton, vegetables, rain fed crops, cattle, poultry	1.1
Perennial Mixed (12)	High production intensity and commercial orientation	145	High	Deciduous fruits, tree plantations, sugarcane	0.9
Arid Pastoral and Oasis (13)	Strong connection between oases and arid surroundings for water and livestock management	15	Very low	Date palms, cattle, small ruminants and off-farm work, scattered irrigated crops	0.4
Urban-Based (14)	Center or fringes of cities, high population density	Variable	High	Fruit, vegetables, dairy, cattle, goats, poultry, off-farm work	

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Annex 2 : Indicators Ghana/Kenya (IDCS2)

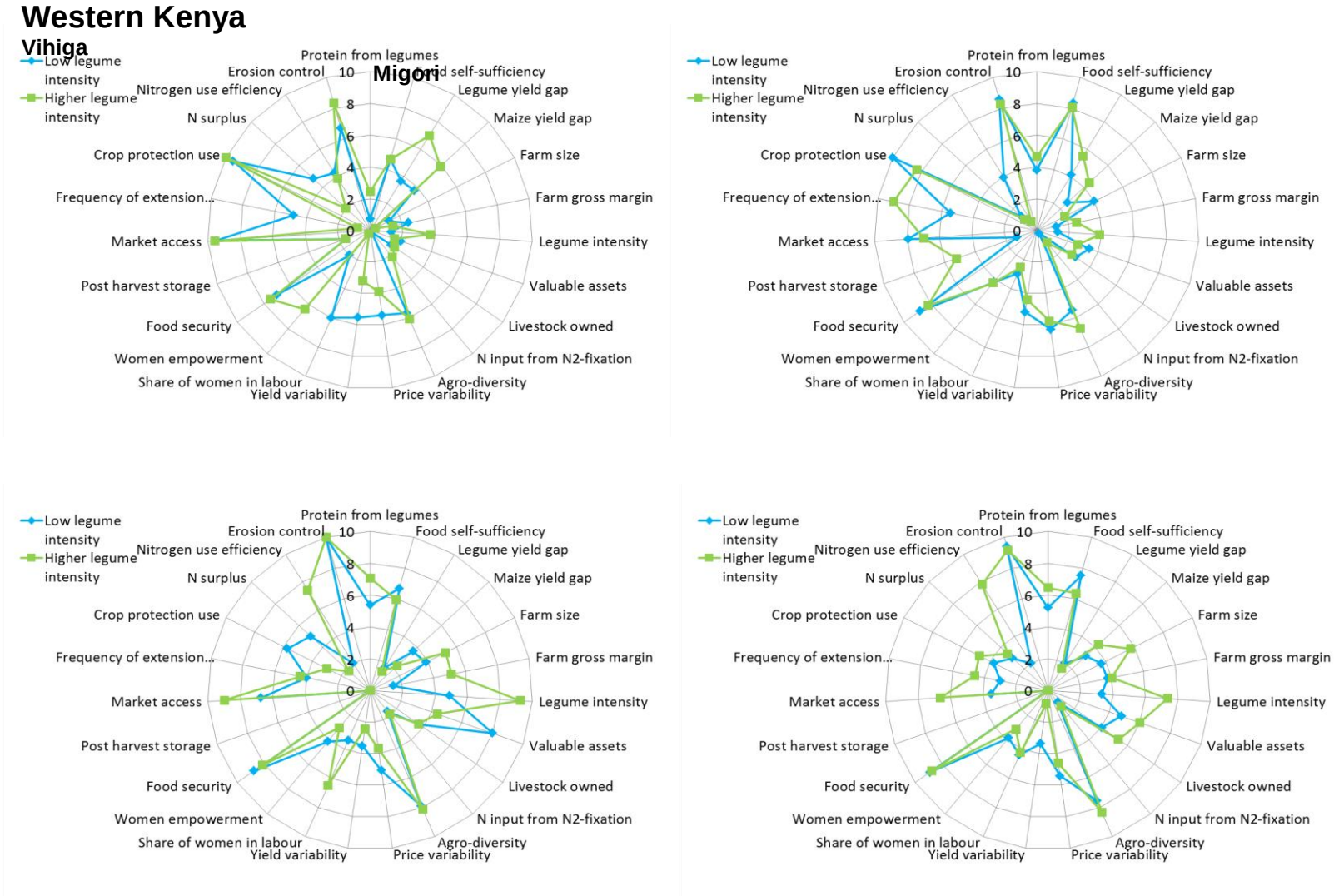

Fig. 1. Average indicators scores for households with a low legume intensity score and a high legume intensity score (averages cross respectively the 50% of the households with the lowest and highest legume intensity) per research site in Western Kenya and Northern Ghana.

Annex 3 : Indicators Madagascar (IDCS4)

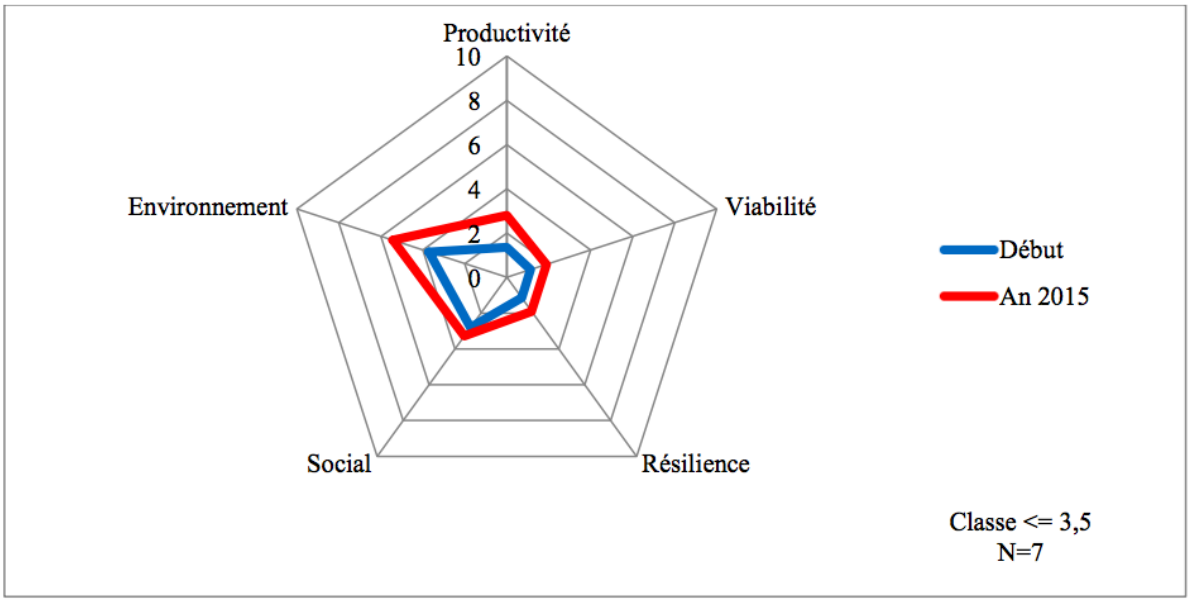

Figure 27 : Évolution des principes d'intensification des exploitations agricoles peu évoluées

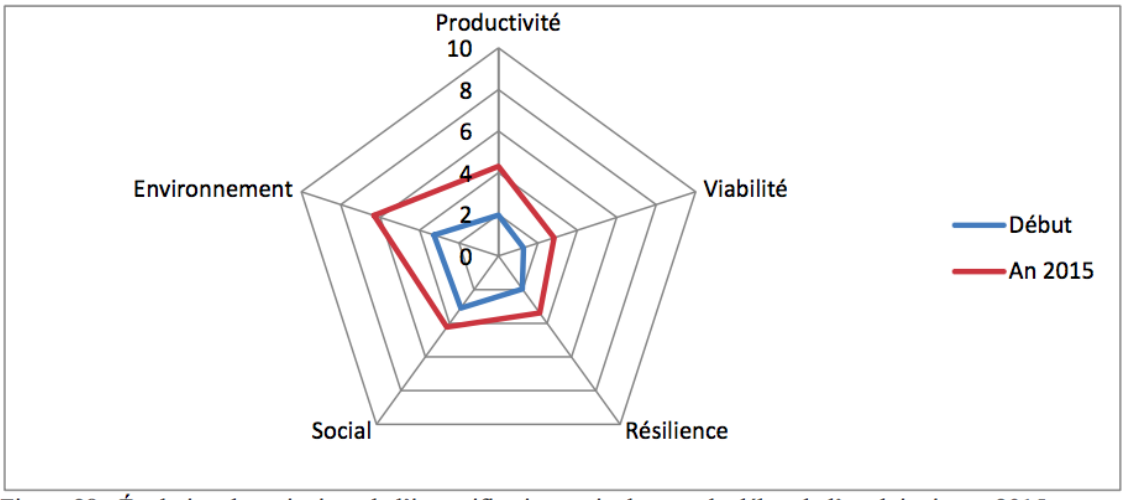

Figure 28 : Évolution des principes de l'intensification agricole entre le début de l'exploitation et 2015