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# Meta-analysis of 3R Kenya findings about the transformation of the aquaculture, dairy and horticulture sectors

Recommendations to support the transition from aid to inclusive aid and trade

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# List of abbreviations and acronyms

ABDP	Aquaculture Business Development Programme
AFA	Agriculture and Food Authority
CASK	Commercial Aquaculture Society of Kenya
EIA	Environmental Impact Assessment
EKN	Embassy of the Kingdom of the Netherlands
ESP	Economic Stimulus Programme
FFEPP	Fish Farmers Enterprise Productivity Programme
FFV	fresh fruits and vegetables
FPEAK	Fresh Produce Exporters Association of Kenya
FSA	food systems approach
GoK	Government of Kenya
HTS	Horticulture Traceability System
ILRI	International Livestock Research Institute
KALRO	Kenya Agricultural and Livestock Research Organization
KDB	Kenya Dairy Board
KMDP	Kenya Market-led Dairy Programme
KMFRI	Kenya Marine and Fisheries Research Institute
QBMPS	quality-based milk payment system
R&D	research and development
RAS	recirculating aquaculture system
SPE	Service Provider Enterprise
WCDI	Wageningen Centre for Development Innovation, Wageningen University & Research
WUR	Wageningen University & Research





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# 1 Introduction

Like many other countries, Kenya is becoming more developed and its bilateral relations are changing accordingly. The 3R Kenya project's objective was to support the ambition of the Dutch government to transition from aid to inclusive aid and trade and investment approaches in its bilateral engagement with Kenya. 3R Kenya, as an applied research and learning project, examined programmes and investment that promote private sector and market-led approaches to agrifood sector development, including those supported under the food and nutrition security programmes of the Embassy of the Kingdom of the Netherlands (EKN) in Kenya. These programmes, run in the periods 2012–2015 and 2014–2017, mainly aimed to support private sector development and transformation in the aquaculture, dairy and horticulture sectors by creating an enabling environment and level playing field for Dutch investors and businesses. The aid support in these programmes was considered investment funding rather than donor funding and aimed to leverage more private investment.

The transition of the Dutch government was informed by assumptions about how Kenya's agrifood and related socioeconomic systems were transforming as it became a low-middle-income country. 3R Kenya investigated some of these assumptions and unravelled the different drivers of sector transformation with a focus on the aquaculture, dairy and horticulture sectors in Kenya. Funded by the EKN, the project began in 2016 and ended in March 2020. It was implemented by Wageningen University & Research in the Netherlands and African Centre for Technology Studies in Kenya, in collaboration with Egerton University, Jomo Kenyatta University of Agriculture and Technology, Tradecare Africa Ltd., Climate Adaptation Services and Aidenvironment.

Within the 3R Kenya project, we have collected evidence mainly about market-led and policy interventions. This report aims to consolidate the insights via a meta-analysis; that is, we have analysed and compared each of the three sectors similarly, through the perspective of a food system that is in continuous transformation. This enabled us to compare sectors, elucidate trends and sector changes and generate insights that inform policy and practice in addressing challenges and responding to opportunities in the transition from aid to inclusive aid and trade. The leading questions were:

- To what extent do we observe sector transformation, interpreted as a change towards a sector that is more competitive, while also being sustainable and inclusive?
- What are the main drivers of sector transformation? Do we see a move towards better institutional governance in sectors, better supply chain coordination and stronger innovation systems?
- What are the systemic issues that currently affect sector transformation?
- What do we recommend will make the transformation to more robust (better supply chain coordination), resilient (stronger innovation) and reliable (better governance) agrifood systems in Kenya?

## Overview of report

This report brings together results of the many 3R Kenya studies. We did this via the method of meta-analysis which is described in chapter 2. This chapter explains the methodology of the meta-analysis, adopting a systems approach that was developed and tailored to the 3R Kenya project. Chapter 3 contains insights and conclusions about systemic issues in relation to sector transformation. These were obtained from the cross-sectoral analysis of the study results of each of the three sectors, which can be found in Appendix 1. We have used the insights and conclusions on systemic issues to define some overall recommendations in Chapter 4 for investment and further engagement to foster sector transformation<sup>1</sup>. Specific sector analyses are presented in Appendix 1, supported with the references to 3R Kenya and other studies. This data was analysed by applying the sector assessment framework (Appendix 2) and the scores were summarized in an easy overview of each sector via spiderweb diagrams in Appendix 3.

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<sup>1</sup> The respective references of chapter 3 and chapter 4 are found in Appendix 1.



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## 2 Methodology of the meta-analysis

### 2.1 Conceptual framework and terminology used in this meta-analysis

3R Kenya uses a systems approach to understand sectoral transformation in the context of the transition from aid to inclusive aid and trade. This means that we take a holistic approach to understanding the root causes of poverty, food insecurity and unsustainable trade and how they influence a sector's transformation to becoming more sustainable, inclusive and competitive. The systems approach applied by 3R Kenya was gradually refined. We started the project with a conceptual framework that defined three subsystems of the agrifood system where transformation can be observed: the robust integrated food supply chain subsystem, the reliable institutional governance subsystem and the resilient innovation subsystem. The joint development of the robust, reliable and resilient subsystems can determine the sectors' growth towards maturity and make them more attractive for trade and investment.

In the project, we used the following definitions:

- Integrated supply chain subsystem: interactions and exchanges between different supply chain actors, ranging from input (seed) and finance providers, production and processing agents, and retail and trade enterprises
- Institutional governance subsystem: policies, standards and markets that set the playing field for supply chain actors and create and enable the business setting
- Innovation subsystem: the critical players that support innovation (research, extension, dedicated projects) in the three sectors.

During the project, the food systems approach (FSA) has gained popularity globally. The FSA also aims to address the root causes of poor food security and therefore includes a model with relevant socioeconomic and environmental drivers (HLPE, 2014; HLPE, 2017; van Berkum et al., 2018). The added value of the FSA approach to our conceptual framework is that it clearly indicates the relationship between the above three different subsystems and illustrates how the food system can contribute to societal needs that originally were mainly considered under aid development programmes. In other words, FSA provides a good framework to understand the mechanisms behind sustainable and inclusive trade (see Box 1 for further comparison with FSA).

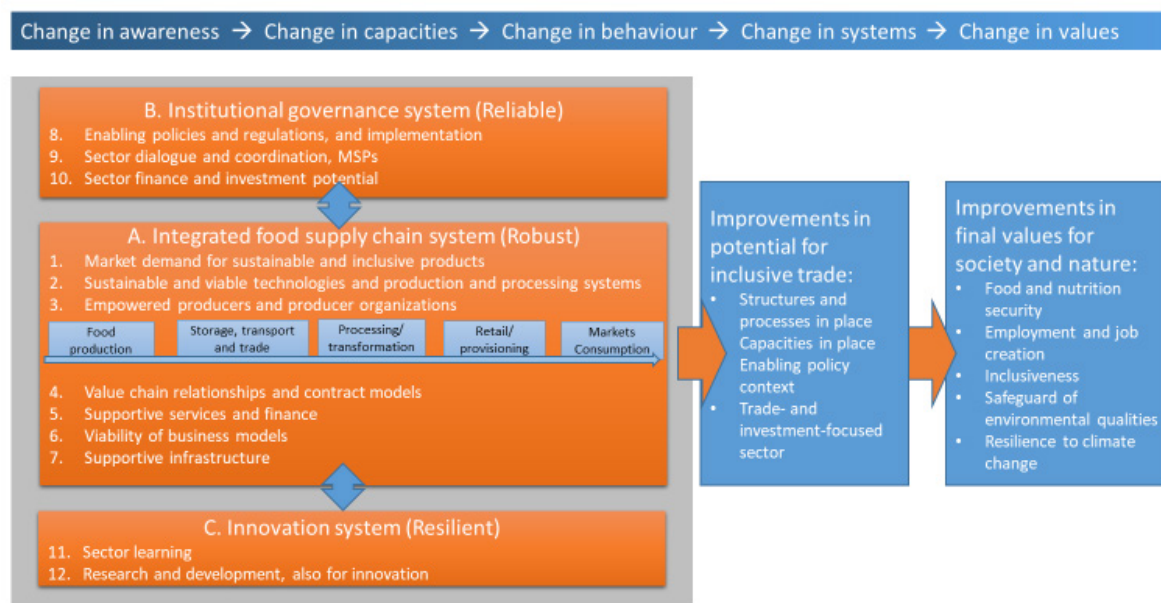
We also added to our conceptual framework the recent experiences and studies by Aidenvironment (in prep) on sector transformation and systemic changes with applications to various agrocommodity sectors worldwide. In this way, we have built a conceptual framework that includes the three subsystems, 12 systemic issues within these three subsystems that play a role in sector transformation, and the resulting outcomes and societal values (see Figure 1). The definition of each systemic issue is found in Appendix 2.

The 12 systemic issues are in fact the root causes of good or poor sector performance. They are part of the wider food system. Changes in systemic issues will be referred to as systemic changes. In this study we interpret sector performance as competitive, sustainable and inclusive. Sector transformation is occurring when all the systemic issues show sufficient positive change over time (i.e. towards being more sustainable, inclusive and competitive).

Systemic changes can be considered as changes at the level of outcomes (changes in awareness, capacities and behaviour of decision-makers related to markets, institutions, policies, etc.). If these changes are positive, they contribute to changes in social values, being improved food and nutrition security, employment and job creation, inclusiveness, environmental qualities and climate change resilience, all of which are also part of the poverty reduction agenda. We refer to them as final values.

Addressing systemic issues also enhances the likelihood of results being sustained and supports scaling by creating a more enabling policy context for improved practices to be applied more widely.

We are mainly interested in developing recommendations for the transition from aid to inclusive aid and trade. Therefore, the level of sector transformation is important, as it indicates a sector's level of 'readiness to do business': its striving to be competitive, inclusive and sustainable, and attractive for investment from private sector. In practice, investment actually occurs as hybrid aid and trade investment, in which the boundaries between non-profit organisations and private sector companies become increasingly blurred (Savelli et al., 2019). This is particularly the case when aid development programmes use market-led approaches.



**Figure 1** Conceptual framework for the 3R Kenya meta-analysis: three subsystems and 12 systemic issues that characterise transformation of food sectors

### Approach to collecting evidence

First, a questionnaire was sent to all 3R Kenya researchers to capture the main results and changes observed from the 3R Kenya activities. Then a workshop was held with the main project researchers, as well as invited sector experts, to capture these results and outcomes. During the workshop, 12 systemic issues were defined and aligned to the 3R Kenya objectives and concepts. To more easily compare the insights of the three sectors and to understand where they are in their transition towards being sustainable, inclusive and competitive, we have defined for each systemic issue what the good or desirable situation is that makes a sector sustainable, inclusive and competitive. For each sector (aquaculture, dairy and horticulture), the following parameters have been scored (see full format with definitions in Appendix 2):

- the status of each systemic issue, scored on a 4-point scale from 1 (very insufficient status) to 4 (status fully in line with the good or desirable situation)
- the trends over the last three to five years, scored on a 3-point scale from 1 (declining) to 2 (no change) and 3 (improving).

If all systemic issues have a status score of 4 or a trends score of 3, the conditions for the sector to transform to full maturity have been achieved or are likely to be realised soon. The scoring was done during the meta-analysis workshop and was based on the knowledge and evidence collected by the 3R Kenya researchers.

Following the sector-specific analysis, a cross-sectoral analysis was done for each of the systemic issues and the interactions between these issues. We were able to generate more generic insights into issues and drivers for sector transformation, using the above conceptual framework and scoring

exercise (see Chapter 2 and Appendix 2). More information on the scoring framework can be found in Appendix 2, and an overview of the scores is found in Appendix 3.

The meta-analysis was finalised by drawing cross-sectoral conclusions about the systemic issues (Chapter 3). These were based on a cross-sectoral comparison and analysis of information on systemic issues for the three sectors (i.e. the current situation, the changes and the remaining challenges). This meta-analysis allowed us to transcend the level of individual sectors and acquire insights of more general applicability. Together, the current state and trends for systemic issues (i.e. systemic changes) determine to what extent a sector is sustainable, inclusive and competitive, or has the potential to become so. Chapter 4 presents the recommendations that are based on how to overcome the issues of chapter 3. A final 3R Kenya workshop was organised with sectoral representatives in March 2020 in Nairobi to validate the systemic issues and to understand the sector's preferences on the way forward.

#### Box 1: Difference between the systems approach and the FSA model

As stated above, the conceptual model for this meta-analysis has gradually evolved and was much inspired by the FSA model. However, it now also differs somewhat from the FSA model.

First, we do not refer to socioeconomic or environmental "drivers". Aid environment's experiences and the 3R research show that several factors or issues strongly influence the potential for a sector to perform (in a sustainable, inclusive and competitive way) and to achieve performance at scale and to sustain this over time. These issues are found within the wider context and relate to the root causes of poor sector performance (such as market failure or unsustainable practices) and are therefore referred to as "systemic issues". These systemic issues could be drivers, but in many cases their current status is poor or insufficient so they are actually constraints. Depending on the perspective taken, these systemic issues could be within the sphere of influence of a decision-maker or development initiative (thus become objectives to be changed or improved) or beyond the sphere of influence (thus become conditions or assumptions to be taken into account). Thus, to summarize, depending upon the current state and the perspective taken, the systemic issues could be constraints, drivers, opportunities, conditions, or objectives. What matters is to define the systemic issues that are most relevant (being the ones in a poor state, hindering progress) and to define who is responsible for their performance and how their behaviour can be influenced or changed. Also, as systemic issues are interrelated, there is a need to understand what the leverage points are and how they can be leveraged.

Second, there are several ways of classifying the systemic issues, as they may have social, economic, policy, political or technological background or origin. For this meta-analysis, systemic issues were defined and classified under three sub-systems that are linked to the 3R approach of robust integrated supply chain system, reliable institutional governance and resilient innovation systems. The conceptual model (illustrated in Figure 1) shows the three subsystems and their interrelations. Central are the systemic issues associated with the (food supply) commodity or sector-related value chains. There are 12 systemic issues that are part of these sub-systems (1–12), where changes are required to strengthen the transformation towards more competitive, sustainable and inclusive sectors. There are also some contextual issues that are beyond the influence of any sector-oriented development initiative, such as demographic growth, urbanisation, climate change, world economy and economic shocks (these are not indicated in the scheme).

#### Food system framework as a strategic management tool

The food system framework is used in the meta-analysis to compare sectors and to reveal systemic issues. These systemic issues can be at the core of new policy support programmes. The framework helps us identify priorities for transformation of food sectors towards desirable levels of sustainability, inclusiveness and competition. The food system framework includes an assessment of the current status (of transformation) to identify remaining gaps or challenges at a systems level, and then identify priorities for action research or for donor support to develop strategies to address priority issues. Ideally, the food system framework should be participatory, thus also contributing to awareness-raising and creating ownership of relevant stakeholders involved. Applying a food system framework can also help strengthen coherence between aid and trade interventions of various bilateral and multilateral organisations. It can be used by Kenyan sectors as a tool to define strategic investments and to enable exchange and learning among key players. It can also be a foundation for further collaboration and a tool to monitor progress in the system transformation.



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## 3 Cross-sectoral insights on sector transformation

This chapter provides the main results of the meta-analysis: the insights into and conclusions about systemic issues in relation to sector transformation. It also presents specific recommendations based on the main insights. Both the insights and recommendations are based on information and data from the sector analyses, to be found in Appendix 1. In the following sections (3.1–3.3), the cross-sectoral insights into systemic issues are presented in relation to the 3R Kenya subsystems: robust integrated supply chain, reliable institutional governance and resilient innovation systems. Reference is made to the contribution by the 3R Kenya project to recent changes on systemic issues, with examples.

### 3.1 Robust: Integrated supply chain system (A)

The systemic issues related to robust integrated supply chain dynamics are:

- A1. market demand for sustainable and inclusive products
- A2. sustainable and viable technologies and production and processing systems
- A3. empowered producers and producer organisations
- A4. value chain relationships and contract models
- A5. supportive services and finance
- A6. viability of business models
- A7. supportive infrastructure.

This section describes the insights into and provides specific recommendations related to one or a combination of these issues.

#### A1. Market demand for sustainable and inclusive products, A2. sustainable and viable technologies and production and processing systems

The productions costs are high, compared to regional and global production systems. This is mainly due to high cost of supply chain transactions

For the three sectors, domestic market demand has increased as has the contribution to GDP. Increased demand is due to growth in population and incomes, as well as government promotion of products of all three sectors. However, it appears to be difficult for domestic production to fully meet the increase in demand, despite good production potential. This is caused by high production costs and poor post-harvest handling leading to high post-harvest losses in all three sectors, both of which are exacerbated by seasonality in dairy and horticulture. High production costs are linked to expensive inputs and value chain transactions cost as well as to low labour productivity, making the sectors less competitive than others in the region or globally. High transaction costs are related to inefficient organisation of the sector. The dairy sector, for instance, has many intermediaries and processors collecting milk in the same area, and even from the same farms.

As a result, the three sectors face competition from imported products and inputs. The dairy sector struggles to compete with dairy products from Uganda and other countries; the aquaculture sector has problems competing with Ugandan and Chinese frozen fish; and the horticulture sector is confronted by seasonal competition of products from Uganda and Tanzania. For fish, with demand exceeding supply, barriers to hamper import will likely lead to a black market, as witnessed in Nigeria (Obwanga et al., 2018).

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An underlying problem is that production costs at farm level are not well documented; as a result, solid evidence on costs of production and transactions along the chain is missing due to lack of consistent approaches for cost calculation. 3R Kenya has carried out a study in the dairy sector which shows that production costs are unclear, partly due to the different methodologies and variables used. Thus, it is difficult to know where to reduce production costs without creating problems for other actors in the value chain.

#### *Recommendations*

- Provide systems including ICT, that can enable effective tracking and analysis of costs of production.
- Address the underlying causes of high production costs (e.g. taxes, labour costs, lack of trust).
- Research the quality of inputs and whether and to what extent they determine productivity during production and the quality of the end product.

Transformation towards more sustainable production and traceability can be triggered by growing consumer awareness about food safety issues

The demand for better food quality is growing but is still limited. This is because the capacity of consumers to pull demand is constrained by information asymmetry related to food quality and safety, as well as regulatory gaps. Furthermore, while consumers may be willing to pay for quality, asking them to pay for safety – especially in a weak governance system – is difficult. Although the growing middle-class are triggering growth in high-end markets that may offer improved food quality and safety, this is not yet a mass market segment.

One assumption has been that practices and capacity to achieve food safety standards in export markets, for instance in horticulture, could trickle down to domestic markets. However, 3R Kenya research showed that this does not appear to happen, partly because of the dominance of informal markets and their fragmented supply chains for all three sectors (see also B4), which do not provide incentives to improve quality and safety.

In the dairy sector, a study of a pilot that introduced a quality-based milk payment system (QBMPS) by a processor into its supply chain showed that the system increased the profit margins for producers, but other actors, including cooperatives and processors, run at a loss (at least in the beginning), due to the high costs of upfront capital investment. Such a market-led approach to improving quality would need incentives for all actors, as well as some level of public investment to drive dairy sector transformation.

3R Kenya also explored the role of traceability systems and certification in driving food quality and safety. It was concluded that a contextualised GLOBALG.A.P. through the less stringent localg.a.p. certification can enhance the diffusion of good production and management practices to enhance safety and quality in the domestic fresh fruit and vegetable (FFV) market. 3R Kenya implemented a food safety pilot to understand how to foster new markets that can drive better food quality through a traceability system. The pilot tested assumptions on whether farmers who produce FFV with higher quality and safety attributes can be linked to identified market segments interested in buying the produce. However, to meet that demand, the traceability systems must be better designed and adapted to local dynamics to guarantee all value chain actors can easily make changes to their current practices. Certification is also an issue for the aquaculture domestic market because consumers do not know whether the tilapia is produced in China or Kenya. Consumers perceive produce from Kenya to be of higher quality and safer than produce from China.

Also, it was found that campaigns and media have not targeted different income groups. The competing public agendas on the economy and public safety compound the problem as the government seems unwilling or unable to push safety through regulation.

#### *Recommendations*

- To support the three sectors to transform to safer and high-quality products, adopt an integrated approach that includes in parallel: diffusing good practices across the value chains; promoting and co-designing (e-)traceability systems that can be easily adopted by value chain actors; increasing



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consumer awareness about food safety hazards, including the effects of pesticide residues, contaminants and heavy metals, which can be detrimental to human health (e.g. cancer, hormonal and neurological diseases, etc.); providing support via extension services; and enforcing safety regulations and high-quality standards through good governance.

- Efforts to implement food safety and quality systems should integrate analysis of public health costs and benefits of these systems so as to guide private and public investments to benefit everyone.
- Explore innovations in new market systems that can better assure consumers of safety and provide incentives for producers.

Production is primarily aimed at increasing productivity, with insufficient attention paid to the environmental impacts, leading to unsustainable agrifood systems. This may affect business continuity

To meet rising demand for food, producers increase their productivity but pay insufficient attention to environmental and social impacts. All three sectors have examples of increased productivity causing environmental degradation. In the horticulture sector, pesticide use has detrimental environmental effects on water, soil quality and biodiversity and poses significant threats to farmers, workers and communities who are directly or indirectly exposed to these substances. Water pollution is caused by disposal of effluent in the dairy sector and by overstocking and use of pesticides in cages and ponds in the aquaculture sector. Environmental degradation will sooner or later affect sector productivity through, for example, water scarcity, nutrient pollution and poor water quality, and thus business continuity will be affected. There is increasing awareness about environmental and climate change issues, and these concerns cannot be ignored anymore. Even financial institutions will increasingly expect their clients to invest in protecting the environment from the effects of their industry.

As farmers are becoming more aware of environmental issues, practices such as waste recycling in recirculating aquaculture systems (RAS) and the horticulture sector are occurring. Recycling may also lead to cost reduction and is therefore beneficial for farmers. 3R Kenya observed that certification plays a role in supporting environmentally friendly practices. In horticulture, certified farmers are more likely to use registered pesticides and pay attention to good hygiene and quality of irrigation water compared to non-certified farmers.

In Kenya, the Environmental Management and Co-Ordination Act and supporting Environmental Impact Assessment (EIA) legislation require businesses to factor environmental concerns into their business planning. However, at this stage the EIA reports are not fully enforced and controlled, and farmers can easily introduce new unsustainable practices like overstocking of cages above the current lake capacity or fishing in shallow waters. Also, the EIA reports do not play a role when exploring new business opportunities. This is a critical issue in the aquaculture sector, where cage culture is rapidly expanding in Lake Victoria. Policymakers have an important role to play to incentivise farmers to integrate environmental issues into their business operations, yet it appears that in practice this depends on farmers taking their own initiative, for which they often lack incentive.

For linkages to climate change, see issue B5.

#### *Recommendations*

- Mitigate environmental risks by defining environmental policies and ensuring their implementation at decentralised levels, such as counties, and by investing in environmentally friendly practices and management systems.
- Improve EIA implementation, especially through enforcement of environmental management plans. Once EIA licences are provided, they should require regular renewal based on regular monitoring.
- At county government level, develop legal frameworks regarding land and water use to incentivise farmers to integrate environmental issues in their business operations.

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Production models and technological innovations, even if successful, often do not show wider uptake nor scaling. One underlying cause is the lack of supportive services, especially appropriate finance for investments. Environmental impacts must be addressed before stimulating wide-scale adoption

3R Kenya has found four main barriers to the introduction and scaling of new technologies. First, farmers struggle with the high investment costs and it costs money to educate people how to run new production systems. Higher technologies are generally more expensive, so while more volume can be produced, the risk of production losses is higher. Second, there is a lack of access to the required investment capital. Third, there are gaps in the services (finance, technical support, advisory services) that need to accompany delivery and commercialisation of the innovation. Fourth, new technologies may not be adapted to Kenyan conditions, or to the particularities of the sector. For instance, the dairy sector has examples of transfer of Dutch technologies that do not fit the Kenyan circumstances and are too expensive. In the case of horticulture, finding a tailor-made traceability system remains a challenge.

Details and examples for each sector are provided below.

**Aquaculture:** RAS tank and cage farming have potential to scale up, provided that environmental issues are considered and costs are shared through integrated value chain models. Cluster farming and RAS fish hubs or satellite fish farming should also be linked to increase farmers' negotiation power so they can access inputs and markets.

**Dairy:** Various production and processing technologies have been introduced, including breeding technology such as semen, semen tanks, cooling tanks, processing and quality assurance technology. The ATM milk dispenser, Service Provider Enterprise (SPE) and QBMPS models have potential to be scaled. 3R Kenya recommends that for scaling of the ATM model, attention needs to be paid to milk quality and the environmental effects from effluent disposal. For SPE, a more holistic package must be provided by the service providers.

**Horticulture:** Greenhouses, biocontrol agents, organic fertilisers, improved seed varieties, ICT systems for data management, cold chain in potato and new traceability systems have been introduced. The export model for food safety can be trickled down to the domestic market. 3R Kenya investigated barriers to and drivers of adoption of horticulture technologies and found that providing medium-tech greenhouses for free does not automatically stimulate demand for greenhouse technology. Consumer perceptions may not align with the new products (e.g. tomatoes from greenhouses are assumed to be unsafe, to be too watery and to have a short shelf life); if the produce cannot find its way to the market, these technologies do not benefit the farmers even if yields are higher. The main driver for greenhouse technologies is the possibility of off-season production, enabling the farmers to get higher prices for their produce.

#### *Recommendations*

- In parallel with introducing innovation, build capacities of extension services and develop financial models to support wide-scale adoption of these innovations. For example, greenhouses should be introduced in combination with financial services that limit the investment risks and with appropriate extension services at installation and regularly during operation. The Kenyan government should invest in building trust in greenhouse products.
- Innovate new technologies through supporting local innovation processes that includes farmers, women and youth, while supporting access to finance for investments.
- Before scaling up, environmental impacts need to be assessed and mitigated.

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## A3. Empowered producers and producer organisations

The viability of producer organisations such as cooperatives remains weak due to limited entrepreneurial and internal governance capabilities and lack of compelling value proposition for their members

It has been shown that producers who are organised have better access to services, such as inputs, and better access to markets. Jointly, they have more negotiation power. Some positive examples are the cage fish farmers association in aquaculture and the smallholder-dominated dairy farmer cooperatives that were established to improve farmer access to inputs and outputs markets. In the horticulture sector, cooperatives and service providers who organise themselves have access to funds and subsidies, in contrast to non-organised producers.

However, cooperatives and producer associations need stronger governance, entrepreneurial skills and ability to provide services to their members to remain viable and perform well. Underlying issues are often a lack of internal trust and producers being passive participants in these organisations. The viability of some of these organisations depends heavily on external subsidies.

A 3R Kenya study has shown that county governments are barely investing in promoting financially viable and strong cooperatives. A positive example is Nyeri County, which has partnered with Nyeri Fish Farmers Cooperative. The cooperative uses the fish-processing facility, which was built by the Kenyan government, to process fish from its members and bulk fish from farmers from neighbouring counties.

### *Recommendations*

- Pay more attention to building the internal governance and entrepreneurial skills of producer organisations, as these are fundamental for long-term viability.
- Promote the opportunity of counties partnering with producer associations, such as the example of Nyeri County partnering with Nyeri Fish Farmers Cooperative.

## A4. Value chain relationships and contract models

Relations between value chain actors are often characterised by insufficient mutual trust and transparency, leading to high transaction costs. New models of cooperation between value chain actors should assure sufficient ownership and benefits for producers

Different contract models are needed to improve cooperation and trust between value chain actors. For example, the model of contractual farming has had difficulty supplying the market with a constant volume, due to challenges related to honouring business agreements. It seems that often those with vested interests benefit much more than the producers. An underlying constraint is the lack of trust and transparency between value chain actors in each of the three sectors. Producers have poor contract conditions and sometimes no contract at all. 3R Kenya research in horticulture found that most of the interviewed farmers do not have a formal contract with buyers. Quasi-contracts are common practice, while established contracts are not being enforced. This also enhances side-selling. Unfair pricing is common and results from an unequal relationship in the value chain and the weak lobbying power of non-organised producers.

New models with hybrid funding structures are emerging. For example, in a public-private model for extension, producers pay for services while also public funds are supporting extension delivery, mainly for aspects that producers cannot pay. SMEs can also benefit and receive support to make good use of the investments.

The dairy sector has some positive examples of strong cooperation between producers, cooperatives and processors. Nevertheless, transparency in payment and in quantities of the products are lacking.

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Processors do not tell farmers the prices. Producers sell their milk to other buyers without informing their contracted buyers. The market-led extension services – such as practical training centres established with the help of public money – are not always sustainable businesses. The willingness to pay for extension services by farmers is still low. Public funds will remain important to a certain extent and it is therefore expected that hybrid extension models will be the best way forward.

In the aquaculture sector, there is no collaboration yet among players in the value chain despite a discussion and exchange platform supported by 3R Kenya.

#### *Recommendations*

- Examine who actually benefits from different models of collaboration between producers, cooperatives and processors, and whether the sector as a whole benefits.
- Develop other partnership models between producers and other value chain actors, with fair pricing as a main goal.
- Further develop the funding models that include both public and private funds (hybrid models) as positive examples of good cooperation between the public and private sector, and whether these can work for other sectors.
- Spend more time and resources building trust among supply chain actors, so they can better identify how they can best tap into market opportunities and co-create strategies.

## A5. Supportive services and finance

Existing market-led service delivery and extension models are insufficient in terms of outreach and quality and tend to exclude smallholders and those who cannot pay for these services

Extension services being part of innovation support services is important for sustainable, inclusive commercialisation of the sectors. There is a clear evolution from dominant public sector delivery to private-led extension services, resulting in a pluralistic system of market-driven extension services. 3R Kenya analysed the emergence of private-led extension services and found that these are expected to improve production. However, due to the plurality, farmers may receive conflicting messages. Currently, there is no regulation to assure quality for extension services.

In the three sectors, while the quality of public extension varies by county, there is generally limited capacity and support from public extension officers to bring the knowledge to the farmers. Extension is delivered, but there is a focus on the organised farmer groups; it rarely reaches farmers who are not organised. Quality extension services tend to be out of reach of smallholders: in all three sectors, there is evidence that they cannot pay for these services. There is a perception from all three sectors that the uptake of new technologies is faster among the younger farmers.

In general, it is not always feasible for smallholders to meet food safety standards. For example, 3R Kenya research in the dairy sector showed that the acceptable level of bacteria in milk under the Happy Cow Ltd. QBMPs was five times that of the internationally accepted standard; however, farmers still found it challenging to meet this standard.

There is also the question of whether farmers can pay for private-led extension services. The business case for these services needs to demonstrate cost-effective service delivery. In the case of Instaveg in horticulture, the price is embedded in the total service package. The purchasing power of producers is rather low, resulting in limited use of improved inputs. Business models of extension services that include both public and private funds – hybrid models – might be the way forward.

Diverse SMEs providing extension services have emerged. 3R Kenya analysed some market-led extension services mainly oriented to agribusinesses that want to be more profitable. However, they fail to scale for many reasons. For example, demand for extension services is not high enough to support privately delivered services. Service delivery is biased to technical support and ignores or

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cannot provide entrepreneurial and managerial support. The private sector is also not clearly regulated.

#### *Recommendations*

- Establish a quality system of extension services; an example is the BASIS qualification for advice on crop protection. Bundling the provision of training or advice with the sale of inputs is a growing market and could therefore be promoted.
- Introduce results-based systems where the extension service seeks to achieve and support clear improvement targets.

### Access to finance remains a major challenge, especially for smallholders and SMEs

All innovations and new practices to improve productivity and avoid environmental impacts require investment; this can take up to three years to see a return. Existing financing models to support investment tend to look for short-term profit, but they are not inclusive in the sense of being customised to farmer conditions and production cycles. Smallholders and SMEs have the lowest access to suitable finance. Due to high risk of failure, SMEs are often not eligible to receive loans from credit institutions.

Many producers are reluctant to buy on credit due to the financial risks, while interest rates of formal loans are too high to be able to pay back, and the procedures to get to the money are long and bureaucratic. Insurance systems are generally not available or are not being used. For example, in the aquaculture sector there is no insurance available. In the dairy sector there is insurance but smallholders (about 80% of dairy farmers) often do not take it out. 3R Kenya observed that informal mechanisms – money from family and friends – are often used to pay for investment costs. Some value chain actors provide better payment conditions to their suppliers.

Details and examples for each sector are provided below.

**Aquaculture:** Access to funding is tied to farmers having bank accounts and being able to show cash flow statements and savings with the bank for them to be regarded as creditworthy. Small-scale and medium-scale farmers are advised to form clusters or operate under cooperatives that can access financing and spread the risk across the members. A successful cooperative is Nyeri Fish Farmers Cooperative, which has enabled farmers to produce fish, save money and benefit from dividends after a certain period.

**Horticulture:** The domestic sector is capital-intensive, especially because of the need for the right inputs at the right time. The ability to purchase certified seed, fertilisers and pesticides and access to credit are key success factors in achieving higher yields and good quality products that meet consumer demands.

**Dairy:** 3R Kenya observed that small-scale producers have poor access to finance, caused by high interest rates. Many credit products are not aligned to the risks inherent in livestock enterprises, which need long repayment periods. This has kept uptake of microfinance products for livestock investment low.

#### *Recommendations*

- Develop new financial models as part of new service delivery models that are accessible for smallholders, including insurance systems.

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## A6. Viability of business models

Testing out different business models along the supply (value) chains can help drive sector transformation. However, the different value chain actors need to demonstrate the viability of their business cases

Innovation, and the increasing demand for products, can enhance employment and business for other value chain actors, such as input providers, transporters and traders. However, innovation tends to focus on one segment of the value chain, often medium- and large-scale producers, and it is assumed that the innovation will spread to other value chain actors. But even if the business case is well developed for one value chain actor, it is not clear that the necessary value will be created that is needed to bring about the expected change throughout the sector.

In dairy, for example, many new business models are piloted, and not only for small- and medium-scale producers, cooperatives and other service providers. For example, there are emerging business models to support fodder production and market systems. But most of these have been incubated through innovation funds and other development support. The extent to which commercial viability can be sustained beyond the project support duration needs to be proven. At the input level, innovative business models are needed that offer quality inputs and services in a more competitive manner to lower milk production costs.

Uptake of innovation is especially low for smallholder producers, which is partly because the production models are not developed in an inclusive way and are not appropriate for them. Smallholders are reluctant to adopt technologies where the risks are high, the outcomes uncertain and the return on investment only marginal. A positive example is from the dairy sector, where maize train silage balers were introduced, supported by SNV's Kenya Market-led Dairy Programme (KMDP), which greatly increased the efficiency of silage-making and the quality of the final product.

A weakness of innovation appears to be that initiatives and their uptake are lost as soon as external funding ends (e.g. greenhouses), which indicates that business cases are not strong enough. Innovation is often highly dependent on external funding during the pilot testing and introduction phases, and due to its supply-driven nature. External funding risks disturbing the market and may even distort the transformation of the various sectors. This includes the free extension services being provided.

SMEs are often a starting point for innovation and business development, but studies have found that many SMEs do not survive the first year. For example, 3R Kenya has found that Kenyan agricultural SMEs struggle with the time-consuming bureaucracy. The horticulture sector would benefit from food processing for new products and value addition; however, the existing food processing SMEs in this part of the sector struggle with high competition and high start-up costs. Also, SMEs have inadequate resources to market the visibility and credibility of the new products.

### *Recommendations*

- Develop and test any business models associated with new production systems or innovation with the different value chain actors, including smallholders, with associated extension services and financial models. This requires more inclusive innovation development.
- When introducing new production models or innovation, avoid dependence on external funding. Instead, use self-financing systems, such as recurrent funding and blended finance mechanisms, as part of a viable business case.
- Support food processing SMEs that aim to add value to domestic production so they can overcome competition and high start-up costs and create local employment.
- Create strong linkages between the sectors and knowledge institutions for generating/adapting and using innovations as well as devising local solutions to challenges in production.

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While efforts are made to include women and youth in all three sectors, an important constraint to engaging youth remains their lack of access to land and to sufficient financial capital or guarantee

All three sectors are taking initiatives to become more inclusive regarding women and youth (15–34 years). The trend of modernisation and the introduction of new technologies have offered opportunities for both women and youth. However, an important factor that risks excluding youth is their lack of access to land and lack of other capital/guarantee. Where credit is provided, often the amount is too low for meaningful investment. An example is the Youth Fund, where funding is about KES 50,000 (~EUR430) to groups; this can hardly support enterprise development.

Details and examples for each sector are provided below.

**Aquaculture:** Cage-farming technology is an attractive investment for youth because it is affordable to start this business.

**Dairy:** The silage-making support by SNV, mentioned above, served different segments of producers. Services were also provided by youths. The required machinery was basic, mainly a maize chopper, and the rest of the work was done manually. One of the 3R studies also showed that women have played a stronger role in the dairy sector since the introduction of milk ATMs.

**Horticulture:** This sector is characterised by a certain level of gender asymmetry. “Women crops” receive less attention by government and investors compared to “men crops”; however, most horticultural farmers in Kenya are women, and most of them lack options to own the land they are farming. While the laws surrounding inheritance are changing, issues about ownership of family land are cultural.

#### *Recommendations*

- In addition to possibilities for youth employment in various value chain activities and service delivery, look at helping youth who want to start a land-based business get access to the necessary land, especially in the dairy and horticulture sectors and for pond aquaculture farmers.
- Create jobs in service provision and value chain segments other than production, for women and youth.
- Especially through the support to SMEs (see above), give more attention to opportunities for youth.

## A7. Supportive infrastructure

Supportive infrastructure is fairly well developed in Kenya. There is improvement in the main roads, electricity and market infrastructure. However, remaining issues are feeder roads (especially in the wet season), improved access to water, and other infrastructure to address post-harvest management issues, such as storage and cold chains, and to serve smallholder producers and remote areas

While government has invested heavily in constructing highways and main roads, the feeder road infrastructure has not received the same urgent focus, which has affected productivity and market access. Poor roads hamper adequate access to inputs as well as ability to bring products to the market for many rural communities, especially in the dairy and horticulture sectors. In the dry season, limited water infrastructure that can enable capture, storage and use is hampering sector growth. Sufficient and good quality water is not always available in both the dairy and horticulture sector. In the aquaculture sector, water shortage in the dry season affects fish production in ponds.

Energy infrastructure is not sufficient, causing unavailability or unreliable access. In the aquaculture sector, even small-scale farmers are experimenting with solar panels to support RAS, which are now available relatively cheap from China. It has been shown that such investments are becoming profitable to farmers.

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The 3R Kenya county study found that county governments are taking a role to finance basic infrastructures that is relevant for sector development. The transport vehicles for local produce are often not appropriate; for example, a lot of horticultural produce is carried in pick-up vehicles or vans that do not maintain the quality of the produce from the farm to the market.

*Recommendation*

- Shift emphasis on infrastructure from roads to cold chains / cooled transport, energy and properly designed transport vehicles. Develop complementary roles for local government and the private sector to play, tailored to the sector and the context.

## 3.2 Reliable: Institutional governance system (B)

The systemic issues related to reliable institutional governance are:

B8. enabling policies and regulations and implementation

B9. sector dialogue and coordination, multi-stakeholder platforms

B10. sector finance and investment potential.

This section describes the insights into and provides specific recommendations related to one or a combination of these issues.

### B8. Enabling policies and regulations and implementation

In many respects, sector policies are in place, but implementation is generally weak, which is linked to lack of policy coherence across governance levels and limited capacity in recently decentralised governments

Devolution of sector responsibilities in the agricultural sector can have both negative and positive impacts on the sector. This is because the counties set priorities and allocate budget accordingly. In cases where sectors are aligned with county priorities, the effects are positive. For instance, aquaculture is a high priority in many counties and benefits from extra capacity-building and business support. However, the dichotomy between functions that have been devolved and those that have not, such as regulatory services, leads to lack of coherence and even conflicts between policies and regulations at different levels (county, national, regional East Africa), which contributes to inadequate policy implementation. Capacity for enforcement is limited, especially at decentralised levels.

*Recommendation*

- Focus capacity-building at county level, to enhance skills and regulatory and governance systems and to ensure finance is sufficient and timely. Plan for capacity enhancement strategically, select sectors to focus on and integrate priorities in the County Integrated Development Plans (CIDPs).

The private sector invests in land and agricultural processing and marketing, but few regulations ensure this investment is responsible. In terms of food safety and quality issues, government agencies are increasing efforts to address the regulatory gaps

There are few regulations ensuring private sector lead investment is responsible, which can create conflict around natural resource ownership, risk allocation and profit sharing. Investment needs to comply with the CFS Principles for Responsible Investment in Agriculture and Food Systems (CFS, 2014), which include respect for land tenure, contribution to food security and nutrition and inclusive governance structures.

Regulations and standards are needed to ensure safe, nutritious and high-quality food products. The private sector has driven efforts to catalyse introduction of regulations and to enhance quality and safety standards. There is also spin-off from export-oriented companies and traders towards domestic markets.



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However, the regulations should also be adequately enforced, which is not always the case. For example, regulations to access and use antibiotics and pesticides are not enforced, leading to negative consequences to human health and the environment. Although regulations require that these compounds are sold under licence, they are freely available on the market and are used to excess in dairy and horticulture. Furthermore, producers do not respect the withdrawal period (dairy) and pre-harvest interval (horticulture).

In dairy, an example of private sector efforts to drive food safety regulations is the introduction of QBMPs. While this has worked for businesses supplied by large-scale farms, it has not worked well in a smallholder-focused supply chain.

#### *Recommendations*

- Identify the regulatory gaps and support the good initiatives taking place.
- Provide better support to help potential private sector investors make responsible investments, which could be by linking them to business-minded people in the sector.
- Provide particular support to smallholders to help them implement food safety standards and use pesticides judiciously.
- Enhance the linkages between private and public extension and farmers, so that there is knowledge exchange on alternative methods for pest and disease control which are proven to reduce the reliance on external inputs.
- Use industry-led regulations through instruments such as codes of practice to help improve compliance.

## B9. Sector dialogue and coordination, multi-stakeholder platforms

The sectors have varying degrees of producer organisation and/or multi-stakeholder platforms (MSPs) for dialogue and coordination, with dairy being the most organised sector. Funding of MSPs often depends on project, donor or external funding

In all three sectors there are efforts to bring together multiple stakeholders through formal and informal networks and platforms. A mapping study by 3R Kenya of sector platforms found that the networks have varying levels of active and passive participation, and their objectives range from technology and institutional innovation support to lobbying and advocacy mandates. The most active platforms are in the aquaculture and dairy sectors, and the export-focused horticulture sector also has active stakeholder networks and organisations. MSPs have important roles related to accountability of re-investment from tax funds as well as watchdog and lobbying functions. In the dairy and horticulture sectors there is evidence of farmers who are in producer organisations having increased lobbying power for affordable inputs, market access and enabling policies, for example. However, there is still limited attention to ensure that producers can negotiate for fair prices, coordinate production or harmonise safety and quality of the produce. The Kenya National Farmers' Federation is currently not functional.

Most MSPs tend to be project-supported, and the innovation agendas are sometimes driven by the donors funding the projects rather than by the sector. Such platforms tend to be short-lived, disintegrating when the projects end. MSPs should be set up from within the sector and be sector-owned to be functional. Furthermore, most platforms are formed in Nairobi at the national level. Regional (East Africa) platforms are not common.

Details and examples for each sector are provided below.

**Aquaculture:** Several types of producer organisations are emerging, such as the Cage Farming Association and the Commercial Aquaculture Society of Kenya (CASK). These organisations now have a seat and a say in the Kenya Fisheries Service.

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**Dairy:** This sector still has challenges in being organized. Efforts to stimulate sector organisation include the Kenya Dairy Board (KDB) convening platforms for dairy processors associations and the Dairy Traders Association, and supporting actors who have self-organised in an online dairy stakeholders forum. These efforts provide platforms for debate, lobbying and advocacy, but they are weak in terms of operationalising intended changes.

**Horticulture:** Being divided into multiple subsectors, this sector shows little coordination in the domestic market (compared to in the export market, where the Fresh Produce Exporters Association of Kenya [FPEAK] is a major player), but an exception is the Nakuru Potato Platform. The Horticultural Crops Directorate, being a public institution, focuses on export rather than on the domestic market despite being set up to support smallholder farmers.

#### *Recommendations*

- Define the means and criteria to support MSPs in a functional way, by assessing their expected roles and responsibilities and the level (national, county) it is appropriate for them to operate in.
- Strengthen the existing public institutions that are playing an important role in developing the sectors and shift the focus to include better the domestic market, not only export.

## B10. Sector finance and investment potential

There is insufficient investment to make the sectors competitive, mainly because large parts of the sector are informal and do not get access to this finance

Regional or global production is more competitive because of lower production costs and/or better quality (see A1). Investment is needed to reduce costs and improve quality, but it is limited. One reason is that in all three sectors, the informal market – which does not generate tax income – still dominates because it has functional activities that fill the gap of what fails formally.

In terms of re-investment by the public sector, each sector differs:

**Aquaculture:** There is investment potential in intensive systems and farming around peri-urban areas, because they are close to the market.

**Dairy:** Investment is mainly focused at processing and less on production; investment potential is mainly in the cold chain and processing as farmers barely make a profit.

**Horticulture:** The levies and licences from export are used for research, but it is not very effective as the research does not address the needs of the sector.

#### *Recommendation*

- Examine the role of informal markets and their role in driving sectoral transformation.

It is of key importance to consider physical and transition risks when making investment decisions in Kenya, as all three sectors exhibit vulnerability to changes in the biophysical environment

While transition risks tend to have built-in lead times, allowing companies to plan and adjust, the abrupt shocks from physical changes in the climate have not received much attention to date. Nevertheless, physical impacts are observed globally and can have abrupt consequences. The IPCC has predicted that in low-latitude regions, even moderate temperature increases (1–2°C) are likely to reduce crop yields. Projected changes in the frequency and severity of extreme climate events will also reduce yields. It is expected that some countries may see increased agricultural potential because of climate change, while others may be negatively affected. In Kenya, for example, agricultural production of maize and beans is expected to increase, while other crops may see declines.

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The financial impact goes beyond physical infrastructure damage, to indirect impacts such as disrupted electricity, increased commuting time and changes in labour productivity. Supply chains can be particularly vulnerable. Within Kenya, this vulnerability will differ from one county to another.

3R Kenya conducted a study on the climate change policy review. The sector innovations in general contribute to more climate change resilience. In aquaculture for instance, cage culture and RAS are more climate-resilient systems than pond aquaculture, which is vulnerable to climate change challenges (droughts and flooding).

#### *Recommendations*

- Assess the vulnerability of different production models and innovations to climate change; make these key criteria for success.
- Support actors to identify possible and realistic mitigation strategies based on the identified climate change risks.

### 3.3 Resilient: Innovation support system (C)

The systemic issues related to resilient innovation support systems are:

C11. sector learning

C12. research and development, also for innovation.

This section describes the insights into and provides specific recommendations related to one or a combination of these issues.

The potential for innovation is reflected in the architecture of research and development, knowledge exchange and the engagement of multiple actors in guiding innovation-focused sector development.

Sectors with well-developed innovation systems are those that show resilience and capacity to adapt to emerging challenges and opportunities. This potential is based on two systemic issues which are further explored:

- the presence and effectiveness of learning and knowledge platforms that facilitate and support knowledge exchange and innovation
- the existing research, development and education systems.

#### C11. Sector learning

In the three sectors there have been efforts to establish multi-stakeholder learning platforms. However, coherent approaches are missing, and the level of innovation could be more effective and demand-driven. The platforms tend to be short-lived, which raises questions about their role in learning and sustainability

In each of the three sectors, there are efforts to bring together multiple stakeholders through various formal and informal networks and platforms. These platforms articulate challenges and opportunities that drive innovation. For example, in the dairy sector, different actors are increasingly forming platforms to interact and share information and to seek solutions to sector challenges. This includes issues such as milk quality and safety, improved access to and quality of fodder and increased competitiveness of the sector. The aquaculture roundtable facilitated by CASK is discussing challenges facing the sector, including issues related to quality and affordable feed, fingerlings and enabling policies. The same approach applies to horticulture, where sector actors come together to discuss issues such as quality and safety and access to appropriate inputs and services. However, the 3R Kenya platform mapping study also showed that most sectors lack coherent approaches to drive innovation in the sector. It is also not clear how innovation agendas are systematically linked to these platforms.

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Another issue is the mismatch between the research and development (R&D) agenda and the innovations requested by the market. The 3R Kenya quick scan noted that the public R&D agenda is mainly supply-driven, in contrast to the agenda developed by the private sector. There is a lack of engaging with sector actors to conduct strategic and forward-looking research. This shows a gap in how research institutes see their role in sector transformation.

Another constraint is that MSPs tend to be short-lived, disintegrating when projects end (see issue B3). Therefore, the extent to which such platforms contribute to building and steering sector-wide innovation agendas is uncertain. Also, despite external funding, a general opinion is that funding remains too limited for agricultural research and innovation.

#### *Recommendations*

- Strengthen the links between research, innovation and development through facilitating MSPs (e.g. the roundtable in aquaculture) or strengthening sector associations (i.e. dairy and horticulture).
- Strengthen the links with sector-based multi-stakeholder or producer platforms so that learning and research on innovation are more demand-oriented.
- Help research institutes better understand and support sector transformation.
- Support sustained funding to sector-based multi-stakeholder or producer platforms so they will be long-lived and can continue to support learning and innovation.
- More clearly articulate the innovation and learning agenda as part of sector development plans.

There is a general lack of production and marketing data from smallholders and a secrecy about data from medium- and large-scale producers. This constitutes a serious constraint in innovation and learning trajectories

Smallholder farmers do not keep records because they do not see value in it or they find it challenging to combine record-keeping with other farm activities. Furthermore, farmers are not well informed about why data could be of value to them. Medium- and large-scale producers may not share data because of fear of competition or to escape revenue taxes. In all sectors, collection and sharing of reliable production and marketing data is very complex, which makes it difficult to assess the viability of business models and their social and environmental impacts. This can also hinder future investment and innovation, particularly from foreign investors.

#### *Recommendations*

- Include data management and the strategic use of data as topics for extension.
- Implement strategies to guarantee farmers benefit from the data they collect and make it easier for them to combine that with their farming activities.

## C12. Research, development and education systems

Increasingly, new technologies or products are being introduced to the sectors, led mainly by the private sector. However, the skills required for wider adoption are still limited. New and promising advisory and service models that support capacity development for innovation and production are being developed

While education levels in Kenya are generally high, the skill levels that industry needs are still a challenge. There appears to be a lack of competence-based training in secondary, vocational and academic education. The private sector has taken up the role of closing this skills gap by developing practical training services, offering internship opportunities to university students. 3R Kenya assessed some of the emerging models aimed at enhancing practical skills in dairy (Practical Dairy Training Centres), horticulture (Latia Resource Centre) and aquaculture (Kamuthanga Fish Farm). These practical training centre models are financed through public-private partnerships, with major donor funding. However, the business case and long-term sustainability of these models still need to be demonstrated. New models are also emerging to foster innovation and entrepreneurial skills. In the dairy and horticulture sectors, 3R Kenya has investigated innovative extension and advisory service models that are conduits for new technologies, knowledge and practices through different market arrangements.

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#### *Recommendations*

- Give more attention to practical training services and vocational training, to support uptake of innovation.
- Conduct research on business models for private-led innovative extension and advisory services.
- Continue co-financing of hybrid business models of some crucial extension and advisory services.

Research, development, knowledge exchange, learning, education and training are key to innovation for sustainable and competitive agrisector development

There are research, development and innovation efforts in all the three sectors led by both public and private sector actors. The research led by national and international public research institutes is working on a variety of research agendas across the different sectors, such as Kenya Marine and Fisheries Institute (aquaculture), Kenya Agricultural & Livestock Research Organization (horticulture and dairy). Private sector research is conducted mainly as in-house R&D activities to support development of products and services linked to the sector, such as biological crop protection solutions. Increasingly, research and innovation efforts are undertaken through public-private sector partnerships that promote close cooperation between different sector stakeholders. These collaborations can transform into 'diamond' /inclusive business innovation collaborations that drive local innovation processes. These are collaboration between private and public sector, together with universities, research, NGO's and financial sector. These collaborations are supported through funding by the government, donors and private sector.

#### *Recommendations*

- Support new partnership/diamond models that stimulate effective interactions between researchers, industry, extension and education to foster innovation and sector transformation. Favour an inclusive business innovation ecosystem.
- Focus research not only on the export market, but also on practical tools that can support improved performance of smallholder farmers.

### 3.4 Final values: Food and nutrition security, employment, inclusiveness, environmental qualities

#### Food and nutrition security

All three sectors have contributed significantly to food and nutrition security. However, it is uncertain that those most in need of improved nutrition are significantly benefiting from innovations in the three sectors, with the possible exception of dairy.

**Aquaculture:** Most programmes (e.g. the Economic Stimulus Programme [ESP] and the Aquaculture Business Development Programme [ABDP]) have food and nutrition security as a key objective. The ABDP began in 2018 and will run for eight years. While a key output that will directly benefit the poor is an initiative that funds schools to have fish ponds, growth of commercial aquaculture is generally contributing to demand for fresh fish among the middle-income population. The Government of Kenya (GoK) has also focused on promoting and breeding fish that is in high demand locally (tilapia) as well as exploring other potential local species like the African catfish.

**Dairy:** This sector contributes significantly to local food and nutrition security for both rural and urban populations: 86% of households across all income groups consume fresh milk, and annual per capita milk consumption is high (~115 litres). The growth is steady: between 2013 and 2018 intake of milk by processors increased by 21.3%, and production volumes grew by 11.7% for processed milk and cream, 46.1% for cheese and 1.5% for butter and ghee. Demand for processed milk and dairy products is concentrated among the urban population, especially in the middle and upper income groups.

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Some county governments prioritise primary school milk programmes in their development plans, to improve food and nutrition security for the pupils. Such nutrition programmes have potential for scaling and benefiting all social groups. Consumer organoleptic taste preferences create market and business opportunities for milk vending machines (ATMs) that sell affordable milk to all social groups. ATM milk retails for two-thirds the price of packaged milk. However, non-compliance is prevalent, with aflatoxin levels exceeding the standard by 50%, presence of antibiotic residues and hydrogen peroxide by 7.9% and bacterial counts by 23.7%. The media plays a key role in creating more awareness about food safety issues for drinking milk and dairy products, which is also steered by 3R-initiated dialogues and the pilot with Happy Cow on the QBMPs in Kenya.

**Horticulture:** This sector contributes to food and nutrition security improvement through income generation, employment creation on the production side and through the micronutrients that FFV add to the predominantly carbohydrate diet of most Kenyans. With regards to FAO/WHO recommendations, the consumption of FFV is only 50% of the recommended amount for the poorest consumers and 68% for the wealthiest consumers. For example, FFV are sold in very small amounts in Kibera slum, and little diversity is available. Increasing the diversity on offer can result in considerably improved nutrition for the poorest consumers.

## 2. Employment

All three sectors have contributed to job creation and an increase in employment. Job creation is direct (producers) and indirect (other employment in the value chain, especially service provision). All three sectors show good potential for more employment, especially in value-added activities, with opportunities for youth and women.

**Aquaculture:** Direct employment opportunities are available for more than 500,000 people, and over two million people are supported indirectly.

**Dairy:** About 1.8 million households are engaged in dairy for their livelihoods (milk, cash, manure, insurance and social capital). Indirect employment is significant, but there are no data available.

**Horticulture:** In 2014, over six million people across Kenya had jobs in this sector (i.e. production, processing and marketing). Another 3.5 million people were believed to benefit indirectly through trade and other associated activities. Increased employment, both skilled and unskilled, is expected, and wages are expected to increase. But this employment can only be assured with new investment, which is limited due to falling/stagnating profitability in the sector and initial high investment costs. The sector, particularly food processing SMEs, is currently in short supply of qualified workers.

## 3. Inclusiveness

There is evidence from all three sectors of improved inclusiveness, that is, engagement of youth and women at different levels in the value chains. However, there is good potential to further improve inclusiveness, especially at levels other than production

**Aquaculture:** Women and youth are actively involved in and benefit from the aquaculture value chain in the country. However, the degree of involvement, participation and benefit is low and varies between households and counties. The ABDP targets women, youth, the landless and other disadvantaged groups as key beneficiaries. Aquaculture is currently attractive to youth who are keen to embrace technology in aquaculture production, and Nyeri County has vibrant women's groups practising commercial aquaculture.

**Dairy:** This sector is the most inclusive of all the agriculture sectors. 3R Kenya found evidence of high levels of youth inclusion in a fodder preservation business and identified necessary modifications to enhance the viability of the business model. There is a push for inclusiveness as evident from the production and processing interventions made by the government and NGOs, but technology transfer by the private sector is targeting medium- and large-scale commercial farms and firms because they are more able to mobilise the required investment capital.

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**Horticulture:** There is a high concentration of women and youth in different parts of the value chain. Youth (15–34 years) constitute two-thirds of the labour force and are often in low-paid jobs. While there are clear inclusiveness policies at national level, a policy to promote gender and youth inclusion in horticulture specifically is lacking. However, policies without further strengthening the concept and practices at local level would be ineffective, because changing culture takes time. For example, while the laws surrounding inheritance are changing, practices of family land ownership are cultural; change is not yet occurring at the pace needed to push the sector towards higher inclusiveness.

#### 4. Environmental qualities

Environmental degradation is occurring in all three sectors, especially aquaculture and horticulture, as a side effect of intensification and increased productivity. Negative environmental impacts need to be avoided or mitigated, as otherwise production systems (which depend on land and water resources) will be undermined.

**Aquaculture:** Organic and inorganic waste materials cause pollution in the aquaculture sector. RAS systems are considered environmentally safe and sustainable as they recycle water and use space well. Production in earthen and lined ponds poses a risk when water is released from these systems. Currently, there is a growing problem of unregulated increase in the number of cages in Lake Victoria. The sustainability of this type of farming in the lake is threatened by failure to adhere to standard operating procedures for cage culture, including carrying out EIAs and audits and use of good quality feed.

**Dairy:** Sustainability issues in this sector are hotly debated, for example, land and water use, greenhouse gas emissions, emerging and re-emerging zoonotic disease outbreaks, and manure issues around Nairobi. This is a consequence of the intensification of milk production, which enhances productivity but has negative effects on soil and water, and therefore on public health. This necessitates significant governance changes to effectively check environmental externalities and ensure compliance with biosecurity and biosafety regulations and requirements. The sensitivity to environmental issues remains relatively low in both production and processing.

**Horticulture:** Environmental impacts in this sector are due to pesticide and fertiliser run-off from fields and its effect on water quality, and improper disposal of pesticide containers. Pesticides, if not applied judiciously, have negative implications on for instance water quality and pollinator diversity. The sector is prone to the effects of climate change, as seasonal rainfall patterns change, severe weather events such as droughts and floods increase and increased temperatures make areas unsuitable for some crops. Some counties and the national government are aware of this and are developing policies to support the horticulture sector to become more sustainable and climate-resilient. However, the counties lack technical capacity to identify appropriate measures to adapt to climate change. International standards such as GlobalG.A.P are being introduced for the export sector, but so far are having little spin-off for the domestic market.

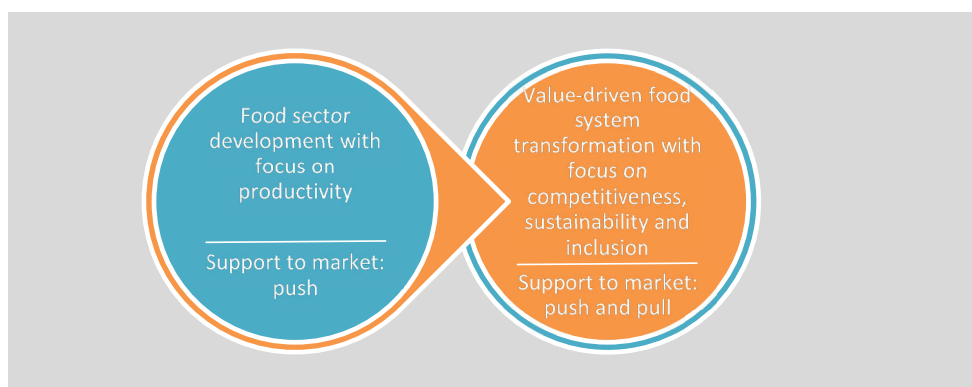




## 4 Policy recommendations to support the transition from aid to inclusive aid and trade

### 4.1 Introduction

This chapter aims to interpret the results of Chapter 3 in the scope of EKN's food security programmes and presents recommendations for the next stage(s) of the transition to inclusive aid and trade. The main conclusion is that this transition should go hand in hand with strategy changes in policy support. Overall, we expect policy support programmes to experience the following strategy changes.



**Figure 2** Strategic policy support shift

The overall strategic policy support shift that is projected to take place is illustrated in Figure 2. The former food and nutrition security programmes at EKN, as articulated in the MASP 2012–2015 and MASP 2014–2017, mainly aimed to improve food supply. The focus has been on improving food productivity by supporting the development of the agriculture sectors and stimulating their growth. Measures to enhance food production primarily focused on the supply chain subsystem and, to a lesser extent, on the institutional governance and innovation subsystems. More specifically, MASP 2014–2017 aimed to increase sustainable agricultural production, improve access to local and international markets and improve the business climate, including access to finance as well as increased Dutch trade and investments. In other words, measures were in place to make sure sector development was supported, food production would take place, productivity would improve, and products would find their way to markets and consumers. Providing food in sufficient volumes is important, but it is equally important that sectors become more competitive: firstly, to produce food in the most cost-effective way, and secondly, to keep on innovating to ensure that food is produced in line with consumer needs and values, that it is produced sustainably and inclusively and that food provision reaches all social layers of society. Thus, sector development and food production are seen within the wider enabling context (institutions, markets, environment).

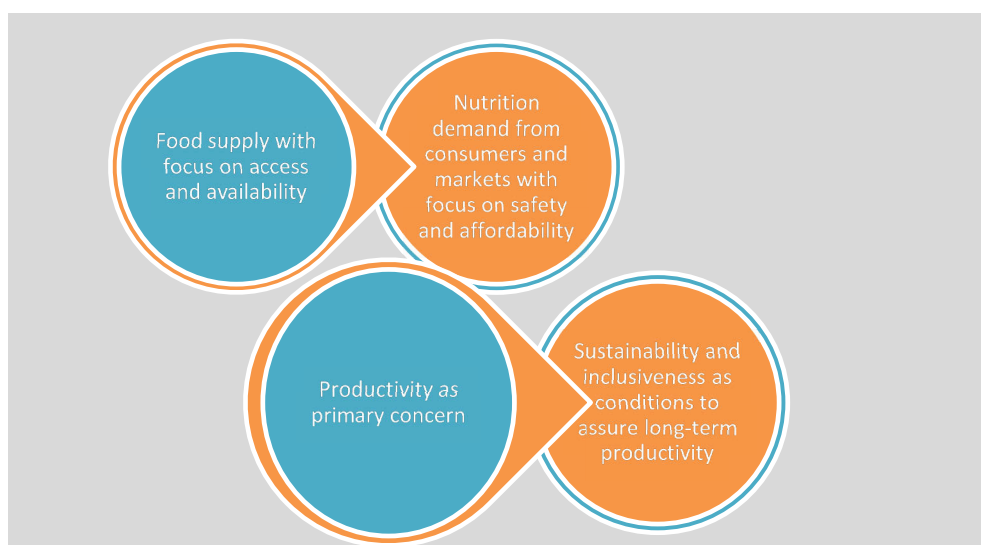
To strengthen the food system, we recommend that upcoming policy programmes change strategy from the focus on food supply to a focus on competitiveness, sustainability and inclusiveness. Competitiveness can be stimulated by an integrated food system approach that focuses on the supply chain, policy support and innovation. In terms of policy support, we recommend that it focuses on (1) strengthening the institutional governance system to enable sectors to grow while reducing transaction costs, and (2) improving the innovation system to reduce production costs and increase production margins. At the core of this policy support is value-driven food system transformation through raising awareness of consumer needs as well as strengthening domestic market mechanisms. In this way, producers are challenged to innovate and will become more competitive.

In section 4.2 the above strategic changes are further developed and grounded by specific and operational recommendations.

## 4.2 Specific policy recommendations for strategic changes

### A. Recommendations for a robust supply chain subsystem

To strengthen the supply chain subsystem, we recommend a strategic change from focusing on improving access and availability of food towards meeting the nutrition demands of different income groups. This implies shifting to the broader food system that focuses on sustainable production, processing and distribution of nutrition-sensitive food products, food safety, food accessibility and affordability for different social and income groups (see Figure 3).



**Figure 3** Supply chain shift

In MASP 2014–2017, the policy was to increase agriculture production (food supply). Policy efforts from counties, national government and bilateral programmes have also focused on increasing food supply. In the meantime, food safety is becoming a key issue for different reasons. First, food safety result from increasing productivity by using large volumes of chemical supplements (fertilisers and pesticides). As mentioned earlier, all three sectors have examples of increased productivity causing environmental degradation and water pollution; this will sooner or later affect productivity through, for instance, water scarcity. The use of chemicals will affect food quality and water quality, thus affecting human health. Secondly, awareness of food safety is increasing but only in certain social groups. Many consumers and retailers are not yet aware of issues of food safety and environmental impacts. Additionally, some social groups do not have the means to pay for safe food, even if they are aware of food safety issues. Thus, there are strong relationships between food safety, environmental sustainability and inclusiveness. Thirdly, local informal markets should play a role in food quality and safety, but their potential to do so is still uncertain.

We recommend supporting the Kenyan government and the sectors by:

- raising awareness and debate among consumers, business and producers about the real costs of poor food quality and safety on health, supported by evidence from studies
- stimulating domestic market demand for improved quality and safety, by:
  - raising awareness about food quality and safety in different income groups
  - developing business models where farmers and processors benefit from their investments in better food quality and safety
  - supporting farmers to assure quality standards while being connected to domestic markets
  - continuing to support farmers to get connected to export markets.

To reduce environmental pollution, and thus also enhance food safety and inclusivity in food systems, we recommend supporting the Kenyan government and the sectors by:

- mitigating environmental risks by defining environmental policies and ensuring their implementation at decentralised levels, such as counties, and by investing in environmentally friendly practices and management systems
- supporting policymakers in incentivising farmers to integrate environmental issues into their business operations (some county governments are starting to take up this responsibility and are developing legal frameworks regarding land and water use)
- taking into account climate change, environmental impacts and inclusiveness when financing innovations and scaling of new models.

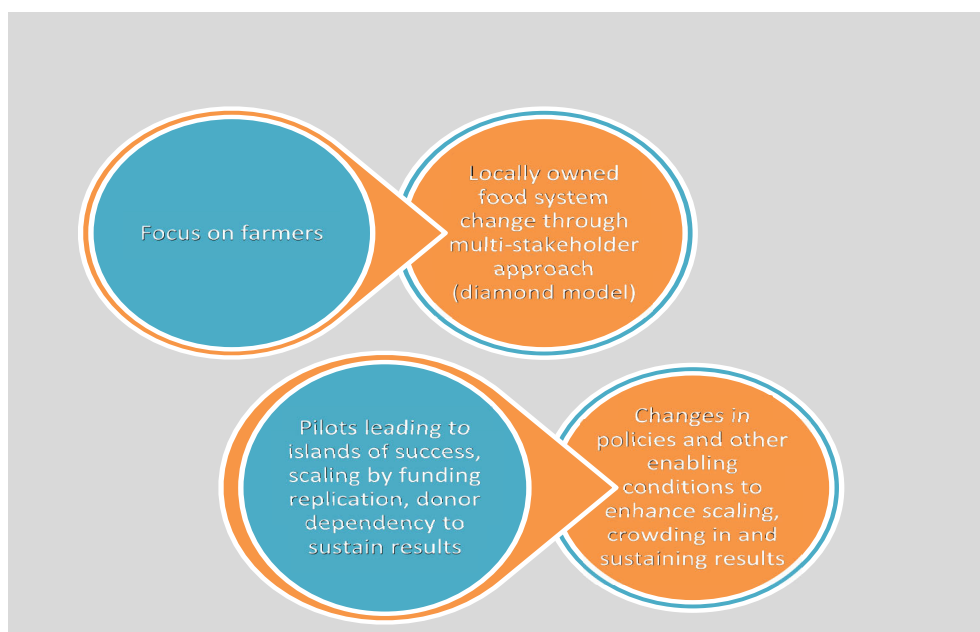
#### Suggestions during the final 3R Kenya event

During the final 3R Kenya event, sector partners emphasised the need for cooling infrastructure to ensure the quality and safety of products. Therefore, we recommend that county governments and the private sector further invest in infrastructure that contributes to better quality and safety along the value chain.

- Aquaculture sector participants need support to improve transport and cold storage.
- Dairy sector participants need equipment to test the safety and quality of milk quickly and cheaply and want government support to improve consumer awareness about quality issues. They also hope to improve milk quality by improving fodder quality, so need investment in the commercial fodder chain, including fodder sales by farmers and distribution by service providers.
- Horticulture sector participants hope to get support for stronger food control systems and the use of certification, as well as having research conducted on the real costs of unsafe and poor quality products. All sectors are need more government support in food quality and safety regulation.

## B. Recommendations for a reliable institutional governance system

To strengthen the institutional governance of food systems, we recommend a strategic change from a focus on farmers to one on multi-stakeholder approaches that show leadership in food system and sector transformation. We also recommend a strategic change from a focus on pilot programmes to one on improving enabling conditions for scaling and sustaining results. This shift in institutional governance system is illustrated in Figure 4.



**Figure 4** Institutional governance shift

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In the MASP 2014–2017, farmers were the focus and were supported to link to local and international markets through public and private partnerships. Dutch NGOs and entrepreneurs played a role in linking trade and development. The activities in the MASP also focused on improving the business climate by improving access to finance for technology adoption and policy dialogues about, for instance, tax and trade policies. Our evidence revealed that a major issue is high transaction costs, which result from a lack of trust and lack of formal/informal contracting between value chain actors. We also found that MSPs are often established by bilaterally funded projects and collapse as soon as the project ends. Partnership models between producers and private sector actors are needed that encourage fair pricing, as is collaboration on persistent sector challenges. These partnerships should be supported by other organisations according to the diamond model, including government, research, education, financial institutions and NGOs. Institutionalised and long-term collaboration networks are key to supporting sector growth and responding to new challenges. The stronger the social network between the diamond model partners, the better the cohesion and the stronger the institutional governance system. During the 3R Kenya final event, we were happy to hear that Nakuru County has established a collaboration platform called CASCOM.

To contribute to stronger collaboration between stakeholders, we recommend supporting the Kenyan government and the sectors by:

- supporting hybrid investment models that work together with strong public–private partnerships. These models will result in mutual benefits and better business relations.
- exploring and promoting sector-based collaboration mechanisms that are financially sustainable and capable of meeting societal challenges. There are different options: MSPs, public–private partnerships, living labs, cluster collaborations, regional development strategies. These collaborations can be made financially sustainable through taxes, membership fees or by reinvesting funds generated within the sector. The collaboration should be driven by a sector agenda on issues of competitiveness, inclusion and sustainability. Exchange, learning and innovation are key in the collaboration.
- Make use of informal networks to support collaboration for sector growth.

We observed that many pilots have been undertaken, but these remain islands of success and scaling does not take place. This is partly explained by the pilot paradox, where pilots are too isolated from the existing institutional context. There is a need to better understand, strategise and prepare the scaling of pilots through the use of policies, other actors crowding in and enabling conditions. That is, enhancing policy coherence can support scaling; improving access to funding through addressing the current high funding thresholds and bureaucratic procedures will support scaling; and focusing pilots on criteria of being inclusive, safe, nutritious, sustainable and climate-proof will support scaling.

Therefore, we recommend supporting the Kenyan government and the sectors by:

- supporting government to enhance coherence between policies at different levels.
- strengthening capacity for implementation of coherent policies.
- exploring policy options to unlock and direct sector transformation towards inclusivity, competitiveness, health (food and nutrition security), safe food and environmental sustainability.
- supporting businesses and NGOs to align with the key principles of inclusivity by promoting the inclusive business scan. The scan was developed by 3R Kenya and supports investments in more inclusive businesses.
- supporting the development of financial instruments that are accessible for scaling new models and practices that have proven to meet criteria of being sustainable, fair and competitive across informal and formal market segments.

Our evidence has illustrated that some pilots and services will also need hybrid funding models during the scaling phase. Private-led extension service is difficult to achieve because not all smallholders are able nor willing to pay for it, even though they would benefit from the service. Therefore, we recommend supporting the Kenyan government and the sectors by:

- exploring which pilots and extension services are only viable and scalable if being supported by hybrid funding; these should be financially supported by both public and private actors.

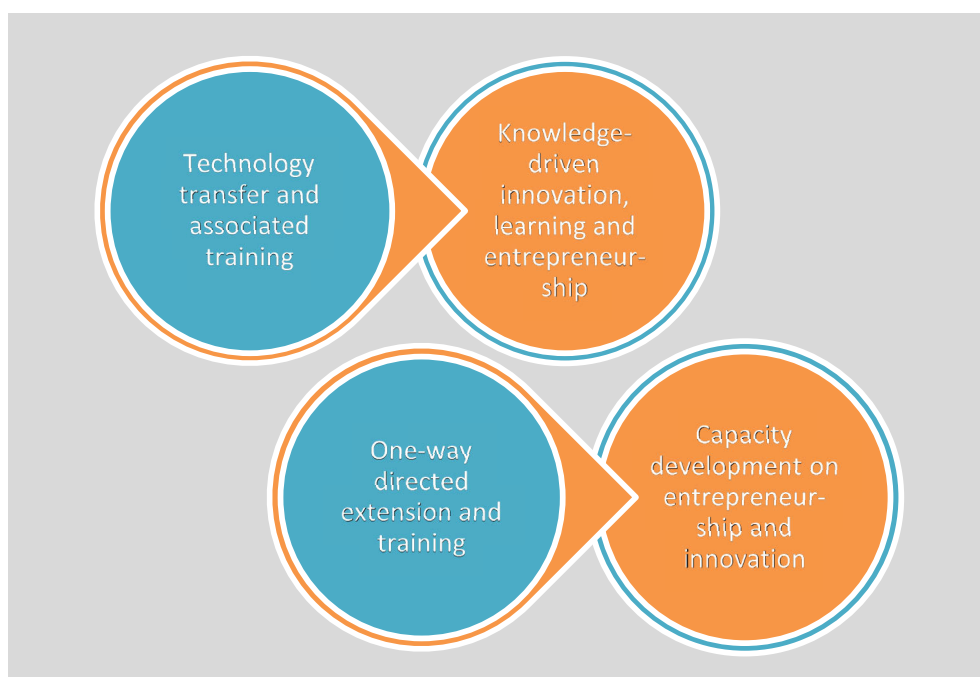
#### Suggestions during the final 3R Kenya event

During the final 3R Kenya event, sector partners emphasised their needs with regard to the institutional innovation system:

- Aquaculture sector actors need policy support and better streamlining of regulation between the East African countries to ensure fair competition between the farmers.
- Dairy sector actors would benefit from more business collaboration to strengthen business ethics and overcome high transaction costs. They would like the cooperatives and county governments to build up much-needed fodder reserves.
- Horticulture sector actors want policies that guide climate change resilience in the sector. The climate atlas can play a role to enhance policy support. There was a wish to engage with government at national and county level to foster coherence in climate adaptation planning and budgeting. The sector is very much aware of the use of advocacy based on evidence and pilot results as a tool for sector transformation.

### C. Recommendations for a resilient innovation system

To strengthen the innovation of food systems we recommend a strategic change from policy support for technology transfer to policy support for locally owned knowledge-driven innovation of technologies and management practices that is fostered by learning and entrepreneurship. We also expect that the focus on extension and training in agricultural practices will change towards capacity development for entrepreneurship and other relevant skills. This shift in the innovation system is illustrated in Figure 5.



**Figure 5** Innovation shift

The MASP 2014–2017 invested to connect Dutch businesses with Kenyan farmers to, for instance, provide greenhouse technologies. Our evidence has indicated that this common practice of technology transfer is often a misfit with local circumstances, and that it would be better to co-design technologies with Kenyan partners using a model of inclusive business ecosystem rather than transfer. Co-design is driven by exchange and learning at the sector level and can help generate ownership and be more oriented to market demand. The co-design and learning subsystems require involvement of relevant private, public and civil society stakeholders, and could take the form of sector-based multi-stakeholder or producer platforms and associations, for example, processor organisations. There is a need for training and extension oriented to the specific capacity needs of producer organisations, especially in terms of their internal governance and entrepreneurial skills, as these are fundamental

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for long-term viability. Furthermore, to develop and enforce environmental and food safety standards requires capacity-building at decentralised levels such as counties. There is also a need to build capacity for strategic planning within sectors and to integrate sector priorities into the CIDPs. Lastly, given the increase in private-led services there is a need for more quality control on these services.

We therefore recommend supporting Kenyan innovation by:

- using public funds to co-invest in private-led capacity-building in innovation'
- promoting a system to assess the quality of capacity development services, for instance through clear improvement targets
- supporting long-term and stronger collaboration and sector learning between research and sector agencies via innovation agendas, (applied) research and sectoral learning experience programmes. In this way, knowledge-driven innovation can take place. The model of inclusive business ecosystems could be favoured
- promoting demand-driven capacity development services.

For inclusive trade to happen, the accessibility and inclusiveness of innovations for low-income groups, smallholders, SMEs, women and youth needs to be improved. There is a need to better understand what smallholders need so they can adopt innovations, whether low-income groups have job opportunities and whether SMEs can benefit from value chain innovations. Potential adoption is often related to services and access to finance, thus these aspects must be integrated in innovation pilots from the beginning. Jobs can also be created in the value chain in service provision, and segments other than production, for women and youth. Especially through the support to SMEs (see above), more attention could be given to opportunities for youth.

We therefore recommend supporting Kenyan inclusive trade for different income groups by:

- investing in capacity development services tailored to different income groups and actors in the diamond
- promoting demand-driven capacity development services that are supported by hybrid funding models catering for the different income groups
- stimulating studies on evidence for improved inclusive trade models
- developing and testing different finance models with different thresholds to increase the access of youth and women to credits.

#### Suggestions during the final 3R Kenya event

During the final 3R Kenya event, sector partners emphasised the following requests with regard to innovation system:

- Aquaculture sector actors are still looking for innovation and investment in good, affordable fish feed. The sector would also benefit from collaborative research for the industry.
- Dairy sector actors mentioned the need for innovation on fodder conservation and food seed that suits the different agroecological zones. They are looking for ways to achieve the protein supplement in cow rations.
- Horticulture sector actors see the key priorities for innovation as climate resilience and food safety in the domestic market. They also requested expanding the extension models that are financially sustainable via cooperatives, and exploring the most affordable financial models. Investment is needed in ICT services along the value chain.

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# Appendix 1      Current status and transformative changes per sector

## Aquaculture

### A. Integrated food supply chain system

#### **1. Markets and demand for more inclusive, safe and sustainable products**

Fish and fish product consumption in Kenya was reported to be 189,000 MT and 192,000 MT in 2017 and 2018 respectively (KNBS, 2018, 2019). The fish industry contributes 0.8% to GDP (KMFRI, 2017). Aquaculture has grown rapidly in Kenya over the last decade, and Kenya is now the fourth major producer in Africa (KMFRI, 2017); production from aquaculture systems grew from 4,218 MT in 2006 to peak of 24,096 MT in 2014, representing 15% of total national fish production. This growth is mainly associated with government intervention through the intersectoral Economic Stimulus Programme (ESP) in 2009, whereby KES 22 billion (approximately USD 283 million) was channelled into key sectors from 2009 to 2012.

However, since the peak in 2014 the subsector has registered decreased performances for three years. The total fish output dropped by 14.7% from 15.0 MT in 2016 to 12.8 MT in 2017 (Obwanga et al., 2020). Yet Kenya has capacity for much more fish farming, with over 1.14 million hectares potentially available to enable production.

Demand for aquaculture products is also growing because of the GoK “Eat more fish” campaigns, a growing middle-class economy that can afford it, and dwindling stock from capture fisheries.

The fish trade network is struggling with high production costs, specifically for tilapia which is competing with cheap imports from China: 22,362 MT of fish in 2019, up from 19,127 MT in 2017 (State Department of Fisheries, 2019). The value of fish imports has been rising steadily in the past four years. This Chinese supply in the domestic market provides, on the one hand, stability in supply that encourages more people to consume fish. On the other hand, Chinese imported fish is cheaper, making Kenyan-produced tilapia less attractive to consumers. The Kenyan tilapia has high production costs, attributed to expensive feed and seed, poor farming methods and high post-harvest losses. Frozen Chinese tilapia costs KES 210/kg, while the price of Kenyan-farmed tilapia has been rising to its current levels of KES 450–500/kg. With demand far outstripping supply, an importation ban will automatically precipitate an unnecessary black market in fish as witnessed in Nigeria (Obwanga et al., 2018).

#### **2. Viable technologies, production and processing systems**

There are three prominent aquaculture production systems in Kenya: ponds, cages and tanks, characterised by different intensities of technologies and different productivity levels. The intensities range from 500 kg/ha/year to 1,500 kg/ha/year for extensive ponds (Kamstra et al., 2014; Rothuis et al., 2011). For intensive farming (mostly in cages, tanks and RAS), the productivity ranges between 10 and 80 T/ha/year. The predominant system is semi-intensive, mainly using fish ponds. However, new farmers have invested heavily in intensive fish farming technologies, such as cage culture, RAS, and aquaponics, but this is still at the infancy stage. Tilapia is the most farmed species (about 75%); other species include the African catfish, common carp and trout. Although aquaculture production does not have the volumes to warrant processing and export, some farmers add value to fish (fish sausages, fish samosas) to access the supermarket chains (Koge et al., 2019; Kyule et al., 2016).

Pond farming occurs across the country; tank farming is mainly located in urban and peri-urban areas, while cage farming is mainly done in Lake Victoria. Interest in cage culture in Lake Victoria is growing

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and production is now about 12,000 MT/year, which is 81% of total aquaculture production (Opiyo et al., 2018). Cage culture and RAS are intensive and resource-efficient as well as more climate-resilient than pond aquaculture, which is vulnerable to climate change challenges such as drought and flooding (Aura et al., 2017; Mustapha, 2014).

Transfer of sustainable and viable technologies is segmented and limited to input supply and production segments. For tanks, the RAS system has been designed for African conditions and can minimise feed costs (by up to 50%), increase survival rate (by up to 25%), reduce water use (by up to 99%) and improve control over water quality and temperature conditions (e.g. FoodTechAfrica, 2019). Moreover, use of solar energy is becoming more attractive, even to less intensive RAS farmers (Koge et al. 2020). In cage farming, circular cages are being embraced over rectangular cages because of the advanced technology for multi-feed opportunities. In a few cages in Lake Victoria, sensors have been used which may signal a move to certification practices, but this is at a very early stage. In the case of intensive pond farming, the most advanced technologies used are floating feed, and some are also beginning to use insect larvae as feed (Obwanga et al., 2020).

Most of the new technologies are only affordable to medium- and large-scale holders, not to smallholders. Entrepreneurial youth are also keen on embracing technology and investing in commercial cage and tank farming (Koge et al., 2019; Ngwili et al., 2015; Obwanga et al., 2020; Obwanga & Lewo, 2018).

### **3. Empowered producers and producer organisations**

The 3R Kenya counties study (Coninx & Kilelu, 2020) has shown that county governments are hardly investing in promoting economically viable and strong cooperative societies. Nevertheless, some counties, like Nyeri and Meru, have partnered with and supported cooperative societies. Nyeri County has partnered with Nyeri Fish Farmers Cooperative, which uses the fish-processing facility built by the Kenyan government, to process fish from its members and also bulk fish from farmers from neighbouring counties.

### **4. Value chain relationships and contract models**

The input and output nodes of the value chain are relatively well developed; however, this depends on the production system. For instance, in cage culture, the input (feed, seed and cage material) and output (fish and fish product marketing and distribution networks) nodes are relatively well developed; this type of production system employs about 500 people directly. The growth of cage culture and uptake of its technology has opened up opportunities to generate income for over 4000 people in the rural and urban areas, who are involved in supply of inputs (cage construction materials, feed and seed) and products (table fish) to the various outlets (Githukia et al., 2018; Victory Farms, 2018). In the recent past, a shift from reliance on small-scale farming to medium-scale and large-scale farming has seen an increase in both local and international input providers. Some companies do their own input production, supply and distribution, while international companies like Aller Aqua and Raanan have contracted local and expatriate distributors of feed along the value chain (Githukia et al., 2018).

There has been a marked increase in the number of feed and seed companies since 2009. Notable among these are Sigma Feeds Ltd, Jewlet Enterprises and Unga Feeds Ltd (Munguti et al., 2014). Increased investment in aquaculture has created the need to import equipment and materials, which has also enabled the entry of new actors. In cage culture, for instance, cages made from high density polyethylene (HDPE) are mainly imported from China through intermediaries, while galvanised metal cages and polyvinyl chloride (PVC) fabricated cages are locally made by artisans (Githukia et al., 2018). A well-established fish trade value chain with networks and linkages between actors is already established (Farm Africa, 2016; Fonda et al., 2019). Some of the traders' associations and top fish traders are considered creditworthy by banks and microfinance institutions (Farm Africa, 2016).

While trading in farmed fish is yet to develop fully as few traders engage in it, consistency in supply of farmed fish is necessary to maintain interest in this source of fish. Furthermore, it is considered to be a risky venture to trade in farmed fish due to its lack of popularity among customers (Farm Africa, 2016; Fonda et al., 2019). Nevertheless, small-scale and medium-scale traders collect fish from farmers to sell through semi-structured distribution channels composed mainly of retailers at various

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local markets, while large-scale investors have outlets in urban centres which have freezers and cold rooms to ensure longer shelf life (Githukia et al. 2018; Victory Farms, 2018). Some large-scale cage-farming investors may transport their harvest in cooler vehicles to maintain freshness then sell it to wholesalers who in turn sell to traders in the market centres, hotels and restaurants (Githukia et al., 2018; Victory Farms, 2018).

## **5. Supportive services and finance**

The sector relies heavily on the national and county governments for extension services, but the private sector and NGOs also play a role. Input producers and providers (fingerlings and feed), extension providers and researchers are the most prominent service providers in the sector.

Note that insurance systems are generally not available in the aquaculture sector. Access to funding is tied to farmers having bank accounts and being able to show cash flow statements and savings with the bank for them to be regarded as creditworthy; this is mostly the case for the cage farmers.

Obwanga et al. (2020) have investigated the origins of investment into high-, medium- and low-intensive systems within the cage, pond and tank categories of aquaculture production. In all segments the share of farmer investment is higher than any form of support obtained. However, support of free capital (production system, etc.) is provided mostly to the ponds, and increasingly so for the less advanced who are targeted by programmes such as the ESP. The highest loans are taken out by cage farmers, who have the greatest access to finance. Loans form 20–30% of investment for all intensity levels within the cage farm category. Interestingly, direct subsidies are provided to the tanks with high intensity levels; these comprise about 10% of total investment costs (Obwanga et al., 2020).

Small-scale and medium-scale farmers are advised to form clusters or operate under cooperatives that can access finance as well as spread risks across the members. A successful cooperative is Nyeri Fish Farmers Cooperative, which has enabled farmers to produce fish, save money and benefit from dividends after some time.

Different banks support farmers differently, and the aquaculture sector is not well structured for financial institutions to invest in the sector. Echo Network Africa (Kenya Women Microfinance Bank [KWFT]) is a bank arrangement of a revolving fund, where aggregated farmers pay small amounts as they grow their fish in the cages until they can repay, which means they can access credit. KWFT provides farmers with loans at 8–10% interest rates (Koge et al., 2020).

## **6. Viability of business models**

The viability of business models varies by the different subsectors (cage, tank and pond, where each can either be either low, medium or highly commercial). There is a vertically integrated aquaculture value chain business model including RAS fish hubs or satellite RAS farms around a central fish farm supported through FoodTechAfrica. The viability of the RAS tanks business models independent of public subsidy still needs to be confirmed (Obwanga et al., 2017).

Cage culture is viable and scalable with positive impact to the owner and the value chain but with possible negative impact on the environment and society if not properly regulated. Business models in intensive production systems (cages in Lake Victoria and tanks near Nairobi [peri-urban]) need to become competitive by lowering production costs, improving regulation, improving taxation on inputs, and ensuring policies that stimulate and support innovation in the sector.

In its Gender Impact study, ETC East Africa (2016) proposes three business models for piloting small-scale aquaculture (mainly pond farming): 1) One Acre Fund Model, where contracted farmers can access inputs on credit through their groups and pay back monthly during the production cycle; 2) Fish Farm Inputs Savings and Loans Model; and 3) linking with existing government-run funds such as the Women Enterprise Fund and the Youth Development Enterprise Funds for loans to support aquaculture ventures. KWFT works with women groups in Homabay County where the groups are encouraged to develop a culture of saving and showing evidence of cash flow before they qualify for a loan. This helps them to be creditworthy for funding from other banks and microfinance institutions.

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## 7. Supportive infrastructure

The aquaculture sector is impeded by infrastructure gaps. The GoK has invested in main roads networks, but feeder roads connecting pond production sites are still of bad quality and not always usable in rainy seasons (KNBS, 2018). Counties aim to invest in infrastructure for farming at county level, such as fish breeding/multiplication stations, storage, processing and cooling facilities. They also invest in road infrastructure and fish market facilities (Coninx & Kilelu, 2020). Processing, cold chains and cooled transport are not accessible to small-scale producers because of small volumes. Electricity from the national grid is not reliable enough for RAS tank producers, who rely on back-up diesel generators to supply energy for water pumping and aeration. This creates additional costs and air pollution. Alternative green energy sources have recently been explored in the sector (Koge et al., 2020).

### B. Institutional governance system

## 8. Enabling policies and regulations, and implementation

Several policies provide guidance to the aquaculture sector transformation: National Aquaculture Policy and National Aquaculture Strategy and Development Plan (NASDP 2010–2015). At the moment, the sector is managed by the State Department of Fisheries and Blue Economy under the Ministry of Agriculture, Livestock and Fisheries. Key examples of their work include implementing cage culture guidelines and fish seed and feed quality standards.

The Fish Farmers Enterprise Productivity Programme (FFEPP), initiated under the ESP and the ABDP, have focused on small-scale farming with an objective to alleviate poverty and assure food and nutrition security. Focus on small-scale farming has also been implemented through subsidies, although there is a risk that farmers become dependent on these.

The “Eat more fish” campaigns are a visible effort by GoK to create and support the market at national level for farmed fish; recently, some county governments have taken it up. The Investment Promotion Act No 6 2012 aims to promote and facilitate private sector investment in aquaculture.

Devolution from central to county governments had both positive and negative effects on aquaculture. After devolution, some counties did not consider aquaculture a priority sector, but others did (Nakuru, Kakamega and Vihiga) (GoK, 2019; Koge et al., 2019). Some have even implemented similar programmes to FFEPP, where they subsidise farming (Koge et al., 2019). The GoK is also implementing the ABDP in 11 priority counties in the Western and Central parts of the country.

Despite policies and regulations being well written, implementation of them at county level is weak due to lack of funding or overreliance on donor funding (Coninx & Kilelu, 2020). Regulation is weak, with cases of poor quality in fingerlings and feed being common. There are serious concerns about the absence of strong environmental legislation relevant to aquaculture, which may undermine productivity (Njiru et al., 2019).

There are guidelines and regulations for residue monitoring, aquaculture inspections, veterinary supplements and medical use. Increased volumes of production and vibrancy will definitely draw GoK attention to streamline food safety issues in the sector. Siting and farming in cages is unregulated, and there is potential for an environmental disaster.

## 9. Sector dialogue, coordination, MSPs

There are several MSPs, the most vibrant being the registered Commercial Aquaculture Society of Kenya (CASK), which brings together stakeholders across the supply chain, including farmers, input providers, financing institutions and national and county governments. CASK has brought different stakeholders on one platform to lobby government for better working conditions in the sector. CASK represents stakeholders in the supply chain and the private sector at the Kenyan Fishery Service, which is the highest entry point for lobbying with the GoK for the sector (Koge et al., 2019). One important weakness in this multi-stakeholder platform is its reliance on external funding to hold regular meetings. In addition, there are other common interest groups allied to the capture fisheries, for example, the Aquaculture Association of Kenya, Kenya Fish Processors and Exporters Association

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(AFIPEK), Cage Farmers Association, as well as fish farmers' cooperatives. Platforms have organised stakeholder forums for articulating issues such as quality and quantity of inputs, tax on imported equipment and materials. Guidelines and standards for feed and seed production have emerged out of engagement between government and the sector stakeholders. Platforms have also increased in number and diversity.

3R Kenya has participated in, noted the evolution of and supported the linking of value chain actors through stakeholder platforms. 3R notes the entrance of the Cage Farmers Association onto the CASK platform as evidence of increased diversity in the stakeholder forums and platforms. Farmers have also coalesced around cooperatives in counties, for example, in Kakamega, Busia and Nyeri.

## **10. Sector finance and investment potential**

As stated above, the "Eat more fish" campaigns by GoK have been supported by various subsidies, which risks making producers dependent.

The national government through its institutions (e.g. Kenya Marine and Fisheries Research Institute [KMFRI]), the devolved governments and stakeholder platforms all have a vision to grow aquaculture to be profitable sector that is recognised for current and future poverty alleviation and that can ensure food and nutrition security, job creation and reduction of pressure on capture fisheries. Several counties have included aquaculture in their CIDPs and strategies, such as Nakuru (GoK, 2013).

The GoK, through its programmes and policies, has mainly focused on small-scale pond production (extension, research training and subsidies). Small-scale production is characterised by low yields, dated technologies, low technical skills, low quality of inputs and inadequate credit. However, it is the opposite case for highly commercial tank and cage farming. Quality inputs (especially feed), equipment for intensive farming and financing are limited to a few intensive cage and tank farmers.

GoK is the key source for knowledge provision (extension and training) but it is overstretched. As a result, other sources of unregulated private extension are emerging, which exposes farmers to the risk of getting the wrong information. Farmers have also complained of getting conflicting information from different extension providers. The ABDP, while working with smallholder-based aquaculture, is implementing contractual farming, through cooperatives or a limited liability company or public-private-producer partnerships, small aquaculture groups or aquaculture support enterprise.

## **C. Innovation system**

### **11. Sector learning**

The platforms noted above ensure that stakeholders in the value chain know each other and exchange information directly or outside the platform. Opportunities for information sharing are available through events such as workshops, trade fairs and field days. Both GoK and NGOs have played a key role in information exchange. The fisheries departments in different counties have often participated in the Agricultural Society of Kenya shows to disseminate recent aquaculture technology and practices. In fact, the role of the County Governments Act (2012) requires the devolved units to monitor fish farming activities in the county.

### **12. R&D and innovation**

The sector has well-established institutions for research and training in aquaculture; however, the challenge is still to make the outcomes of research and training meet the requirements of the sector. Key research and training institutes in aquaculture include a number of public universities, KMFRI, the Kenya Wildlife Service, the National Aquaculture Research Development and Training Centre. Some counties have also incorporated aquaculture into vocational training in a bid to promote it among youth. Funding for research and training from the GoK may be limited, but the sector has benefited from research funding from different NGOs, international governments and programmes. For instance, research for cage culture development has been funded by the EU through the BOMOSA project in 2007 and funding through the Association for Strengthening Agriculture Research in East and Central Africa project (KMFRI, 2017; Njiru et al., 2019; Obwanga & Lewo, 2017; Obwanga et al., 2018; Opiyo et al., 2018).

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Perhaps one of the key successes in KMFRI is research on cage fisheries which has contributed to the vibrant growth of cage culture on the Kenyan side of Lake Victoria. Training and research are well linked and are implemented collaboratively. However, a structure that can manage the linkages is lacking; hence, institutions rely on networks created by the researchers and trainers or on MOUs arrived at by the different institutions. KMFRI is also using technological platforms to support sharing market information across the aquaculture value chain (KMFRI, 2017).

## Final values categories

### **Food and nutrition security**

The GoK has targeted aquaculture as a sector that contributes to food security specifically at the small-scale level for decades. Therefore, most programmes supporting aquaculture (e.g. ESP and the ABDP) have food and nutrition security as a key objective. The ABDP programme began in 2018 and will run for eight years. A key output with direct benefits for the poor through community nutrition is an initiative to fund schools to have fish ponds which are used in the School Fish Feeding Programme. Furthermore, the growth of commercial aquaculture is contributing to demand for fresh fish among the middle-income population. The GoK has also focused on promoting and breeding fish that has is in high demand locally (tilapia) as well as exploring other potential local species like the African catfish, common carp and *Labeo* sp.

### **Employment and job creation**

Aquaculture is a major employer, providing direct employment opportunities to over 500,000 people and supporting over two million people indirectly (Njiru et al., 2019).

### **Inclusiveness**

The current Kenyan constitution provides for inclusivity specifically for vulnerable groups in all sectors. In aquaculture, several examples are available. The ABDP targets women, youth, the landless and other disadvantaged groups as key beneficiaries. Aquaculture is currently attractive to youth who are keen to embrace technology in aquaculture production, and Nyeri County has vibrant women's groups practising commercial aquaculture.

Women and youth are actively involved in and benefit from the aquaculture value chain in the country. However, the degree of involvement, participation and benefit is low and varies between households and counties.

### **Environmental qualities**

Aquaculture has environmental impacts, such as pollution by organic and inorganic waste material. Although pond farming is of low intensity, farmers may use outdated practices such as heavy application of pesticide. Earthen and lined ponds pose a risk when water is released from the production systems into the environment, mostly into rivers and lakes.

The more intensive tank systems use more advanced RAS, which are considered environmentally safe and sustainable as water is recycled and smaller spaces are better used.

Cage culture is attracting attention, given the sensitivity of the environment in which cage farming is carried out and the greater environmental impacts compared with the other systems mentioned above. Pollution is worse with increased intensity in cage production, and there is currently a growing problem of unregulated growth of cages in Lake Victoria, where cages are being installed without consultation with the community and state departments responsible for regulating fisheries (Njiru et al., 2019). Cages are not to be installed in environmentally sensitive areas like river mouths, breeding and nursery zones and at low depth areas, but investors have installed cages in these areas despite cage suitability maps being available (Njiru et al., 2019; Orina et al., 2018). Failure to adhere to standard operating procedures for cage culture, including carrying out of EIAs and audits as required and use of good quality feed, threatens the sustainability of cage farming in Lake Victoria (Njiru et al., 2019; Orina et al., 2018).



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## Resilience to climate change

Reliance on water for production puts aquaculture at high risk from effects of climate change. Pond production specifically is exposed to droughts and flooding. A shift to production using RAS and cages may reduce the impacts from climate change. However, there are limitations of using RAS and cages as they are expensive to install and run and may not be available to small-scale farmers, who make up most aquaculture farmers (Obwanga & Lewo, 2017). Aquaculture is already moving more to cage culture, which is less likely to be affected by severe climate change impacts (such as drought and flooding).

## Dairy

### A. Integrated food supply chain system

#### 1. Markets and demand for more inclusive, safe and sustainable products

Kenya is the leading milk producer in East Africa, and dairy is the largest agricultural subsector in Kenya in terms of income and employment creation. Its annual production is 5.2 billion litres and its contribution to the national GDP is 4% (KDB, 2019). The Kenyan dairy sector creates about 1.2 million direct and indirect jobs, making it a very significant employer in the country (KDB, 2019). The sector is dynamic, with a strong market pull, because of population growth, urbanisation and a growing middle class. It has an average annual growth rate of 4%.

However, the industry's growth and competitiveness for both local and export markets are constrained by (1) low productivity and high costs of milk production, (2) seasonality, and (3) milk quality issues (Rademaker et al., 2016).

1. Average production costs per litre (inclusive of feed, veterinary, labour costs and production losses) (KES 27–36) are much higher than in Uganda (KES 10). This is due to land scarcity and high input and transaction costs. Many Kenyan farmers are not producing at economies of scale, and the supply chain is inefficiently organised. Too many intermediaries and different processors are involved in collecting milk. Unlike in Uganda, most milk in Kenya is produced in smallholder farms, which use cut-and-carry feeding systems. The system is more reliant on externally sourced feed and inputs. Consequently, the farmgate and retail prices are higher, which restricts Kenya's export market opportunities. In fact, dairy imports from Uganda have recently increased to be one-fifth of the Kenyan dairy market.
2. With monthly collected volumes of 11–16.5 million litres, seasonality leads to milk price fluctuations and prevalent breaches of contracts. This happens in both the formal and informal markets. Seasonality can be caused by drought, but primarily it is due to dry and wet season variations in feed availability without adequate feed preservation and high prices for purchased feeds. There is a lack of investment in fodder and climate smart technologies (Ericksen & Crane, 2018). To meet the supply gap, processors reconstitute milk powder, which has been imported. The seasonality also has implications for jobs in ATM milk retailing business (Ayuya et al., 2020).
3. In both the formal and informal markets, there are insufficient incentives to improve milk quality and safety (Ndambi et al., 2019). Consumers are not requesting quality milk, since they are not very aware of safety issues; their willingness to pay a premium for safer milk is limited; and there is a lack of testing and enforcement of existing food safety standards for milk. Farmers and traders still adulterate milk or mix morning and evening milk, which affects its safety. Chain actors have limited finance to invest in aluminium containers that are easier to clean, in cooling facilities, in reliable access to power, or in access to good transportation and roads.

Milk market channels are changing. In particular, the sale of milk through ATMs has increased over the years, which may result in less milk being sold through other informal channels. 3R Kenya studies have made policy recommendations to enhance milk quality throughout this milk retail channel (Ayuya et al., 2020; Bebe et al., 2018a). These recommendations may support growing ATM businesses, stabilise milk supply and improve quality of retailed milk.

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## **2. Viable technologies, production and processing systems**

Approximately 80% of the domestic marketed milk is produced on smallholder farms. The remaining 20% of milk is produced by medium- and large-scale dairy farmers – generally defined as farmers with 20 cows or more. These commercial farms can produce large volumes and invest in fodder production and silage-making. The medium-scale farms are likely to expand more than the small and large-scale farms (Ayuya et al., 2019). Around 75% of the dairy production is estimated to be consumed or traded in the informal sector.

Major processors have their own collection, bulking and transportation systems, but typically obtain milk from smallholders, often through cooperatives. Processors, farmer cooperatives and private firms, as well as county governments (Coninx & Kilelu, 2020), are all investing in expanding processing capacity, mainly for pasteurised milk, which is in high demand domestically. Processing of high value products is rapidly expanding, targeting middle-class urban consumers.

Technological innovations are taking place in areas such as fodder production, production volumes and productivity, processing technologies, advisory services and market intelligence. Improving access to market and milk quality is stimulated by the technological transfer of milk ATMs, which is a retail practice growing in scale. However, environmental issues are rarely a trigger for technological innovation. Examples are manure management; application of climate smart technologies and biogas use; and waste disposal in production, processing and retailing (in ATM vendors) (Ayuya et al., 2020; Ericksen & Crane, 2018; Ndambi et al., 2019).

The problem with using Dutch technologies is that they do not always fit Kenyan circumstances. In the dairy sector, organisations like PUM or Vetvice have played an important role in supporting innovation in the dairy sector by connecting Dutch and Kenyan players (Klerkx & Coninx, 2019). But because many Dutch companies work through local agents, they often promote Dutch products that are inappropriate for the Kenyan market. High costs of Dutch technologies are often a bottleneck for adoption.

## **3. Empowered producers and producer organisations**

Dairy farmer cooperatives are set up to improve farmer access to inputs and outputs markets. They are smallholder-dominated and widespread at the county levels. Despite improvements during recent years, many cooperatives remain weak in governance, entrepreneurial and managerial focus. Consequently, they do not have a strong vision nor a way to support the interests of their members.

## **4. Value chain relationships and contract models**

Of all milk produced, 45% is estimated to be consumed on-farm by either households or calves. Of the remaining 55% milk that is marketed, the vast majority (70–80%) is marketed raw (but boiled before consumption). Informal traders (intermediaries/transporters/hawkers) play an important role in getting raw milk to the market. The remaining 20–30% of marketed milk is processed.

Formal and quasi-contracts are the most common contract models, and they are often breached by the value chain partners. This leads to unfair pricing that perpetuates opportunistic behaviour by all parties involved. With their large milk volume supplies, the medium- and large-scale producers can negotiate with processors for fair pricing and trading practices and enforce formal contractual terms. The value chain partners in both the formal and informal markets have confirmed the need for good and trustful relationships during 3R Kenya Quick scan study (Rademaker et al., 2016). Stakeholders worry about low transparency and lack of traceability. The KDB draft regulations are one of the initiatives to address these challenges.

## **5. Supportive services and finance**

### *Extension services*

Producers and value chain actors can access knowledge, inputs and finance from multiple sources: public, private agencies and NGOs. More and more private-led extension services are delivered to the dairy sector. Diverse SMEs have emerged to provide extension services. In 3R Kenya, we have analysed market-led extension services (e.g. practical training centres), advisory services (e.g.

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Perfometer and ProDairy EA Ltd.) and integrated or chain-embedded services (e.g. training and extension units in Meru Dairy Cooperative Union) that are mainly oriented to agri-enterprises trying to be more profitable (Kilelu et al., 2018). Low professionalism within the SMEs means they fail to reach out to sufficient clients. Service delivery is biased to technical support and ignores or is unable to give entrepreneurial and managerial support. The quality of services varies from county to county and depends on the delivery channels. Certification is unregulated (Kilelu et al., 2018). Accreditation of extension services, like practical training centres, could be supported. Bundling the provision of training or advice with the sales of inputs is a growing market.

The dairy sector is also facing a lack of practical skills, because educated graduates have been taught theory and need to be retrained in practical and soft skills. This results in overheads to entrepreneurs. SNV, through KMDP, piloted practical training of farm managers and supported vocational training to address this skills gap.

#### *Business model of market-led extension services*

We explored the business model of market-led extension services and found that public funds will still be required to cover part of the costs. The willingness to pay for extension services by farmers is still low. It is therefore expected that hybrid extension models will be the best way forward, connecting advice to other services or inputs (Kilelu et al., 2018).

#### *Financial services*

Financing facilities in the dairy sector are mainly oriented to medium-scale farms. Middle-class people particularly are investing in these farms. Small-scale producers, however, have poor access to finance because high interest rates create fear of failure to repay and loss of assets through debt recovery actions. Many of the credit products in the market are not aligned to the risks inherent in livestock enterprises, that need long repayment periods. This has kept uptake of microfinance products for livestock investment low. Most producers prefer informally delivered financial services and limited financing through savings and credit cooperatives.

### **6. Viability of business models**

The commercial and social benefits derived from dairy business models are often not applicable to all supply chain actors. 3R Kenya assessments of piloted business models (SPE, private extension, QBMPS) showed that these models benefit farmers and consumers with technology, input and business opportunities (Ayuya et al., 2019; Kilelu et al., 2018; Ndambi et al., 2019), but are generally unviable for business owners. They need high initial investment and demanding high-level organisation of value chain actors to cope with the logistical challenges. While the models offer a clear business case to beneficiaries, scaling of them is impeded by high cost of implementation and low capacity to invest.

For instance, the QBMPS has potential to assure high-quality and safer milk and is beneficial to consumers and smallholder producers, who receive higher returns than if they market through cooperatives/processors without a QBMPS. Scaling is possible but is limited by how much investment is needed for laboratory and supportive logistics. Innovating for affordable and portable milk quality testing kits and testing on priority quality and safety indicators is recommended for progressive scaling (Ndambi et al., 2019).

### **7. Supportive infrastructure**

Supportive infrastructure for the dairy sector is fairly well developed in Kenya and is still improving in terms of roads, electricity and markets. However, feeder roads, water supply, cold chains, practical education and laboratory capacity still need greater improvements to benefit the sector.

County and national governments are investing in supportive infrastructure at scale (Coninx & Kilelu, 2020). The governments supply farmer groups and cooperatives with milk chilling tanks but there is still insufficient attention for cold chain functioning. Some counties still have poor feeder roads, which hinders efficient milk collection. The medium- and large-scale farms are able to invest in their own chilling facilities.

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## B. Institutional governance system

### 8. Enabling policies and regulations, and implementation

Enabling policies and regulations like the livestock bill and dairy industry regulations are in place or are being revamped, but review of such policies is not regular enough to respond adequately or in a timely enough manner when issues emerge. Furthermore, enforcement at county and national government levels is insufficient, especially with regards to environmental policies and food safety regulations. The implementation gap is related to lack of capacity and inadequate funding (Coninx & Kilelu, 2020).

County and national governments favour subsidies for small producers, but sometimes apply conflicting policies and regulations in taxes and food safety. These policies have implications for food control systems. Furthermore, lack of good manure management policy prevents best use of manure through nutrient recycling for soil fertility, animal feeding and biogas production (Ndambi et al., 2019). One positive is that in the new Kenya Dairy Regulations, currently under review, milk quality has been put higher on the public agenda.

Most policies focus on short- to medium-term development priorities to mainstream sustainable business models and fair trading relations. Kenya subscribes to regional market and trade agreements and commits to harmonisation of regional food safety standards to facilitate regional milk trade but has to deal with societal unrest when these policies hurt Kenyan production. Harmonisation is effected at the regional levels (East African Community and COMESA). Unlike county and national policy, regional policy implementation is effective and applies at scale.

Environmental impacts of the sector necessitate significant governance changes to address and to ensure compliance with biosecurity and biosafety regulations and requirements. Reporting mechanisms for checking disease outbreaks and greenhouse gas emissions from dairy production systems are in place and implemented. However, transparency may be an issue in the reporting of disease outbreaks, because there are no compensation policies and producers absorb the full economic loss in emergencies. The insurance schemes in the market are tailored to drought events.

The 3R project generated evidence on prevalent non-compliance to quality and safety (Bebe et al., 2018a, 2018b). Discussing the effect of poor milk safety on public health has contributed to quality and safety regulation. Policy interventions are currently proposed by the KDB in close collaboration with stakeholders, but its capacity to enforce food safety control systems needs to be improved. Risk-benefit communication is insufficiently focusing on consumers to enhance their protection, confidence and trust in the food safety governance system. The print media can support communication of risks and benefits of quality and safer food (Bebe et al., 2019). However, print media articles are usually biased to the benefits for milk producers, processors and distributors in improving product safety and quality. Focus on consumers has low newsworthiness, although it could foster confidence in marketed milk. Partnerships between media and the regulating authorities is a recommended strategy to bolster the role of print media in communicating risk-benefit of food quality and safety.

### 9. Sector dialogue, coordination, MSPs

The dairy sector has both formal and informal MSPs that host conversations about how to better coordinate the sector, but their functional capabilities in steering a shared sector vision and strategy are questionable. These platforms involve farmers, processors, academia and governments from all levels. Smallholders are generally represented in these platforms, but they often do not have an equal say.

Coordination and partnerships among the stakeholders are yet to be formalised in an agreed set of targets and milestones that adequately and effectively respond to the priorities and emerging issues for sector growth transformation. Critical mass to follow up priority interventions is lacking in the sector. Responses are intermittent and uncoordinated. Consequently, the emerging dairy-related opportunities are lost.

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Evidence generated in 3R Kenya demonstrates segmentation and lack of coordination in the value chain. In presentations to county and national stakeholders, the urgent need for convergence on a vision for the dairy sector was re-emphasised, which has triggered emergence of platforms at county and national levels that can support local and national identification of the emerging dairy-related opportunities.

#### **10. Sector finance and investment potential**

The dairy sector provides good prospects for investment, but the mechanisms to maintain the sector's long-term competitiveness are inadequate. The steady growth in production, processing and per capita consumption provide business opportunities for investors.

The dairy sector generates revenues from both formal (taxes, levies, fees) and informal trading (KDB, 2019). Re-investment mechanisms are in place in the form of subsidies, regulatory institutions and knowledge institutions to facilitate innovation. The KDB, as regulatory body, is responsible for re-investment of revenues into the sector. Kenya Agricultural and Livestock Research Organization (KALRO) and universities, as national research systems, are mandated to re-invest public funds in innovation that responds to emerging growth issues in the sector.

Investment in the sector largely flows towards processing facilities and medium-scale farms. Small-scale producers are recipients of multiple donor and public interventions, which are sometimes competing rather than complementary. Medium-scale producers mobilise their own resources for investment. Investment risk is higher in production than in processing. Access to financial services (credit and insurance schemes) for producers would improve with a shift to economies of scale; entrepreneurial investment; consistent record-keeping for planning and strategic decisions; and production of safe, quality milk.

### **C. Innovation system**

#### **11. Sector learning**

The government and NGOs support learning platform initiatives, but without follow-up mechanisms to monitor learning.

In the dairy sector, different actors are increasingly forming platforms to interact and share information and to seek solutions to sector-related challenges. This includes issues such as milk quality and safety, improved access to and quality of fodder and increasing sector competitiveness. For example, a WhatsApp group of Kenya Dairy stakeholders actively discusses these topics. AGRIFI, a project supported by the EU and Danida, holds meetings of like-minded partners to discuss safety issues.

#### **12. R&D and innovation**

The government funds agricultural training centres at county levels to give farmers access to demonstrated evidence with which to spur learning, effective exchange and technology uptake. Agricultural shows and field days are commonly used as well to demonstrate evidence that should support learning and uptake by producers (Coninx & Kilelu, 2020). Farmer cooperatives hold field days where learning from evidence may occur. However, other supply chain actors do not get equal support for learning or effective exchange. Knowledge institutions are weakly interlinked with the sector to support learning from their research. The research priorities of the knowledge institutes are set without enough communication with sector actors. The knowledge outputs thus have limited relevance to emerging issues and priority challenges.

3R promoted sector learning from the evidence generated through several approaches, including meetings of experts; county, regional and national forums; and production of practice briefs shared with the wider stakeholder audience. The evidence triggered renewed discussions on finding sustainable solutions to food safety and growing a sustainable dairy sector.

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The 3R Kenya issues brief (Kilelu et al., 2018) on extension services has recommended stronger collaboration between universities and training centres to ensure that students are better prepared for the market.

## Final values categories

### *Food and nutrition security*

The dairy sector contributes significantly to local food and nutrition security of both rural and urban populations but is failing to assure provision of healthy and safer products in the market-led transformation. Across all income groups, 86% of households consume fresh milk, and per capita milk consumption is high (~ 115 litres). Sector growth has been steady between 2013 and 2018 (although the 2017 drought resulted in significant disturbance). Processor milk intake increased by 21.3%, with 11.7% increase in processed milk and cream, 46.1% increase in cheese and 1.5% increase in butter and ghee. Demand for processed milk and dairy products is concentrated among the urban population, especially in the middle and upper income groups.

Some of the county governments prioritise primary school milk programmes in their development plans, targeting improved local food and nutrition security for pupils. Such nutrition programmes have potential for scaling and benefiting all social groups.

Consumer organoleptic test preferences create market and business opportunities for ATMs that sell affordable milk to various social groups (Bebe et al., 2018a). ATM milk retails at two-thirds the price of packaged milk. However, non-compliance is prevalent, with presence of antibiotic residues, hydrogen peroxides (7.9%) and above-limit bacterial loads (23.7%).

### *Employment and job creation*

According to KDB, the Kenyan dairy sector offers direct and indirect employment opportunities to 1.2 million people (KDB, 2019), and there are about 1.8 smallholder dairy farmers. Opportunities for skilled labour are being generated along the value chain due to the ongoing shift in consumption from fresh to processed milk products (low-fat milk, cheese, yoghurt, ice cream, ghee and butter), increasing attention by the private sector to medium-scale dairy farms and growing demand for locally assembled ATMs. Work with livestock accounts for 50% of the agricultural labour force; of this, a significant proportion is in the dairy subsector.

### *Inclusiveness*

Dairy is the most inclusive of all the agriculture sectors, which is very positive. The 3R project found evidence of youth inclusion in a group fodder preservation business and identified necessary modifications to enhance the viability of the business model. Moreover, the fodder production systems that have been introduced are considered to be quite inclusive. There is a push for inclusiveness as evident from the production and processing interventions made by the government and NGOs, but technology transfer by the private sector is targeting medium- and large-scale commercial farms and firms considered able to mobilise investment resources (Ettema, 2019).

Nevertheless, given current land scarcity and the market context, long-term livelihood prospects from dairy will depend on higher added value per acre of land, which is likely to require significant investment. We expect that only the more entrepreneurial smallholders will dare to make such investment, leaving many smallholders with difficulty in making a living from their small farms.

### *Environmental qualities and climate resilience*

The dairy sector has hotly debated sustainability issues: land and water use, greenhouse gas emissions, emerging and re-emerging zoonotic disease outbreaks, and manure issues around Nairobi. This is a consequence of the intensification of milk production, which enhances productivity but has negative effects on soil and water, and therefore on public health. This necessitates significant governance changes to effectively check environmental externalities and ensure compliance with biosecurity and biosafety regulations and requirements.

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# Horticulture

## A. Integrated food supply chain system

### 1. Markets and demand for more inclusive, safe and sustainable products

The market for horticultural products is big in Kenya. In total, the production of vegetables (exotic, indigenous, Asian), fruit, medicinal and aromatic herbs and flowers for the domestic market was valued at KES 236.45 billion in 2017, compared to an export value of KES 115.32 Billion (HCD, 2018). This means that the horticulture sector contributed 33% to agricultural GDP and 38% of the country's income through export (AFA, 2017). 3R Kenya has mainly looked at the domestic market, focusing on vegetables and to lesser extent on fruit, but has used lessons learned from the export market to guide sector transformation.

Three market segments can be differentiated: a segment fully relying on the informal market, a segment relying on mid-level grocery stores, and a niche market mainly in the supermarkets and high-end malls. Growing population, urbanisation and the changing diets of the emerging middle class are the main drivers for growth in the Kenyan domestic market. Particularly popular are African leafy vegetables where demand exceeds domestic supply. For other types of vegetables, there is both regional import and export. Market competition with Tanzania and Uganda is emerging with regards to tomato, onion and watermelon (J Gema [Managing Director, Tradecare Africa] 2020, pers. comm. 18 Feb, 2020) because of better produce quality and lower production costs (USAID, 2013).

The horticulture sector would benefit from value addition (Coninx & Kilelu, 2020), such as through food processing to create new products. However, Mbutia (2019) has revealed that food processing SMEs in the horticulture sector that aim to provide new products to the market struggle with the competition and high start-up costs. Marketing is important and supports the visibility and credibility of any new products. However, marketing requires market research that SMEs may find unaffordable due to inadequate resources and finances. Production scheduling could also assist in matching supply with demand and avoiding variability in supply. This could also be supported by protected cultivation using greenhouses and irrigation.

The demand for better food quality is limited, because consumers have low understanding of intrinsic food quality standards (Gema et al., 2018) and rely on the appearance of food to judge its quality. Furthermore, as they are not yet willing to pay for quality, it is expected that they are also not yet ready to request higher assurance production models. Only middle-class consumers who shop at the high-end market are observed to request for better food quality (RSA, 2015), although demand for better quality is increasing slowly in other market segments (Gema et al., 2018).

In 3R Kenya, a food safety pilot was implemented to foster better food quality through grocery stores as the driver for the demand. In Nairobi alone there are about 130 grocery stores, of which 60 can be classified as low end, 40 as middle segment and 30 as high end (Gema et al., 2018). We have validated the hypothesis that farmers who produce safer and better quality fresh fruit and vegetables can be linked to identified market segments interested in buying that produce. However, this requires strong coordination, technical support and significant effort to ensure proper communication and alignment between the different actors. Better traceability systems, adapted to the horticultural sector, are needed to increase transparency in the domestic value chain of fresh fruit and vegetables. At the same time, adoption of those systems might remain a challenge if all actors in the chain fail to see the value of the extra efforts needed to use those system for better trade.

### 2. Viable technologies, production and processing systems

The most common production systems are rain-fed and irrigated systems on small and medium farms. Intensification varies in production and in processing. Smallholders constitute 80% of all growers and grow 60% of total horticultural produce (MatchMakers, 2017). These smallholders have limited access to markets, finance, production knowledge and labour, which is further compounded by an ageing farm population. As a result, labour productivity is low. This is also caused by a mismatch between educational training, research and industry requirements. Smallholders are reluctant to adopt

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technologies with uncertain outcomes due to high risks and only marginal rate of return on investment (Koomen et al., 2018; Verkaart, 2018). Consequently, smallholders may not be the preferred target for technology adoption programmes.

Technology adoption and transfer is often part of policy and development programmes, but commercial adoption is limited. 3R Kenya has looked into adoption barriers and drivers of horticulture technologies, such as greenhouse technologies, improved seed systems for various crops, increased availability of biological control products, pilots on cold chain in potato and promotion of new traceability systems. Seed systems have been widely commercialised. But the adoption of biological products is limited to large-scale production systems and was mainly driven by the introduction of a traceability system (Chemeltor et al., 2018). For greenhouse use, the main barriers are 1) lack of initial investment capital, combined with high costs and risks, 2) lack of knowledge in adequate greenhouse farming practices and the absence of technical support and service delivery once the greenhouse is installed, and 3) consumer perception that greenhouse vegetables are not safe, too watery and have a short shelf life (Ayuya et al., 2019). Furthermore, it is also often the problem that technologies are transferred from Western countries to Kenya without being adapted to the local context (Klerkx & Coninx, 2019). We concluded that free provision of medium-tech greenhouses does not automatically stimulate demand for greenhouse technology. We also saw that self-financed greenhouses had higher production per square metre than free greenhouses. However, even with higher yields, if the produce cannot find a market, these technologies fail to benefit farmers (Klerkx & Coninx, 2019). Despite the proven difficulties of providing greenhouses for free, many county governments still invest or plan to invest in it (Coninx & Kilelu 2019). However, the main driver for greenhouse technologies is the possibilities of off-season production, enabling the farmers to get higher prices for their produce (Ayuya et al., 2019).

3R Kenya has recommended that in order to encourage better adoption of greenhouse technology in Kenya, simpler and tailored models are needed that fit the local context and knowledge. This should be done in combination with financial services that limit the investment risk and with extension services at the time of installation and regularly during operation (Ayuya et al., 2019). Or technologies should be innovated via an inclusive business and innovation approach (Klerkx & Coninx, 2019). Furthermore, the Kenyan government should invest in building trust in greenhouse products among consumers in the local markets (Ayuya et al., 2019).

### **3. Empowered producers and producer organisations**

Farmers that produce for the domestic market are not yet strongly organised in cooperatives or associations (Matui et al., 2016). Farmers are not yet strongly organised in cooperatives or associations (Matui et al., 2016), which makes it difficult for them to improve the marketing of their produce (Gema et al., 2018). This is one reason the majority of products are marketed through informal markets and end up in the wet market where food safety is not an important factor for consumers in this segment.

Many producers lack specific information about market potential that is needed to strengthen their position. There is a need for entrepreneurial and management skills, as well as understanding of market dynamics and bargaining skills. This highly fragmented sector leads to strong dominance by traders due to information asymmetry (Matui et al. 2016).

### **4. Value chain relationships and contract models**

Kenya has struggled with weak product governance mechanisms in both its export and domestic markets (Matui et al., 2016). Ayuya and others (2019) found that most of the interviewed farmers do not have a formal contract with their buyers. Verbal contracts are the most widely used form of contracting in the horticulture sector. In this form of contracting a buyer must establish, or have the prerequisites in place to establish, a business relationship (Matui et al., 2016). When farmers bring their produce directly to the open market without such a business relationship with a trader, they usually have to sell the produce below cost. Contract farming can offer opportunities for smallholder farmers because the contractor provides the inputs and farmers gain access to the lucrative export market. However, farmers can be lured into binding contracts that give them very little return on



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investments. Farmers who are GlobalG.A.P. certified are mostly engaged in contract farming with companies that buy their produce (Gema et al., 2018).

### **5. Supportive services and finance**

Extension services play an important role in commercialisation of the sector (Kilelu et al., 2018). These services are provided by government, research institutions, greenhouse providers and private extension service providers (Ayuya et al., 2018; Kilelu et al. 2018). We observe a clear evolution from public-led to private-led extension services, resulting in a pluralistic system of market-driven extension services (Kilelu et al., 2018). The 3R project has analysed the emergence of extension services led by the private sector from the firms Mazao Safi and Instaveg (Katothya et al., 2020). These services are expected to improve production. However, due to the plurality, farmers may receive contrasting messages. Currently, there is no regulation to assure quality for extension services (Katothya et al., 2020).

When technologies such as greenhouses are provided, training to use those technologies should be provided as part of the arrangement. Furthermore, it is not yet possible to get higher prices for greenhouse-produced tomatoes, compared to those produced in open fields. But when well-managed, greenhouse tomatoes get higher yields.

The sector is also challenged by limited capacity and support from public extension officers to bring the knowledge to the farmers. Extension is delivered to the organised farmer groups, but rarely reaches farmers that are not organised.

The question is also if the farmers are able to pay for private-led extension services. In the case of Instaveg, the price is embedded in the total service package and is not clear to farmers. The purchasing power of producers is rather low. We expect that hybrid business models of extension services that include both public and private funds will be the way forward (Kilelu et al., 2018).

Farmers in the horticulture sector would benefit from better financial support. Investment costs in technologies like greenhouses are high, affecting the willingness to adopt technology (Ayuya et al., 2019). Many farmers are also reluctant to buy on credit due to the financial risk, which affects their investment behaviour (Wattel & Savelkous, 2018). Some farmers ask for loans, but interest rates of banks are high (Ayuya et al., 2019); up to 12% per year for the duration of 24 months. The income seasonality can make it difficult to repay loans on time. Other payment methods include splitting payment before, during and after installation. In most cases, however, farmers have to pay for greenhouses in one hit, up front, in cash (Ayuya et al., 2019). This is also true for food processing SMEs in the horticulture sector, where practices like 30–90-day payment plans cripple the supply chain. This affects entrepreneurs' ability to procure raw materials, pay running expenses etc. (Mbutia, 2019). Due to high risk of failure, SMEs are often ineligible to receive loans from credit institutions. Interest rates are unfavourable, and the procedures to get the money are long and bureaucratic (Mbutia, 2019). Climate change brings many uncertainties, which makes it even harder for farmers to get credit. Perhaps developments in the insurance sector to help farmers insure their production offer hope.

### **6. Viability of business models**

The business models in the sector are the market intermediaries model (the most dominant), followed by the input-provider model, support-provider model and outgrower model. There is no detailed information about the extent to which these models are viable. Entrepreneurial innovations are critical ingredients for development and economic growth, and SMEs are often a starting point for innovation. But studies have found that many SMEs do not survive the first year. 3R Kenya has found that Kenyan agricultural SMEs struggle with the time-consuming bureaucracy, limited access to finance and barriers to access market (Mbutia, 2019).

### **7. Supportive infrastructure**

The horticulture sector requires good road infrastructure, access to electricity, irrigation, post-harvest facilities and practical training facilities. The study of Ayuya and others (2019) on greenhouse

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technology adoption has found that nearly all tomato farmers have access to electricity, mobile phones and mobile banking.

County governments are positioning themselves as agents to finance the required infrastructure for the horticultural sector. They plan to invest in irrigation schemes, greenhouses and road infrastructure (Coninx & Kilelu, 2020). In Kenya, significant gains have been made overall; however, rural infrastructure remains a significant constraint. Poor road infrastructure hampers transportation of produce to markets (Mbuthia, 2019).

Furthermore, climate change is expected to affect the horticulture sector, mainly due to increasing occurrence of drought. County governments are beginning to invest in water management infrastructure to support farmers (Coninx and Kilelu, 2019; Patrick et al., 2020).

## B. Institutional governance system

### 8. Enabling policies and regulations and their implementation

The major policies that drive sector transformation in the horticulture sector are (Matui et al., 2016):

- the [National Food and Nutrition Security Policy 2011](#)
- the [National Horticultural Policy 2012](#), which emphasises development of the domestic market with regard to production, food safety and post-harvest handling facilities, and the development of physical market infrastructure
- the [Agricultural Sector Development Strategy 2010–2020](#) and the new [Agricultural Sector Transformation and Growth Strategy 2019–2029](#), which identifies horticulture as an important subsector within the wider agricultural sector
- [Vision 2030](#)
- [Big four agenda](#).

In 3R Kenya, we looked into the role of county governments to support the sector, food safety policies and climate change policies. We also touched upon the issue related to trade policies.

#### *County policies*

Given the devolution, national policies have to be operationalised at county level. Gaps in implementation occur due to the fragmented mandate between multiple state agencies and the devolved governments and limited funding mechanisms for implementing certain regulations, such as traceability (Matui et al., 2016). The incorporation of the national climate policies into the CIDPs remains a challenge (Patrick et al., 2020).

County governments have detailed their support to the horticulture sector in the CIDPs. The sector is mainly supported by financing infrastructure at county level and through extension and advisory services (Coninx & Kilelu, 2020). But the county governments also experience implementation gaps due to the way funds are made available and to limited capacities (Coninx & Kilelu, 2020).

#### *Food safety policy*

The policy framework to secure food safety in the horticulture sector is too weak. The food chains are still inadequately managed, leading to chains with low quality assurance and risk of pesticide residues and heavy metals coming from the use of contaminated water sources for irrigation. The National Horticulture Traceability System and Food Safety (KS1758-2:2016) Standard are in place, and various traceability systems exist (Chemeltorit et al., 2018). However, 3R Kenya has found that systems need adjustment to actually serve the horticulture sector. The main limitation of the system is that it is time-consuming to enter multiple crops and plots per farm (J Gema [Managing Director, Tradecare Africa] 2020, pers. comm. 18 Feb 2020).

#### *Climate change policy*

Despite the impact of climate change on the horticulture sector, the national Climate Smart Agriculture Implementation Framework (GoK, 2018a) fails to mention any specific horticulture-related interventions. In addition, the NCCAP (GoK, 2018b) only mentions horticulture in connection with reduced productivity in export of horticulture commodities. We have concluded that climate change

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policies are not yet adequately integrated with policies relevant to the horticulture sector. Lack of proper integration between climatic and other development policies at the national level has meant that counties are unable to understand and exploit linkages between horticulture and other sectors (Patrick et al., 2020). Counties have identified various impacts of climate change and proposed intervention measures. However, the interventions are not based on local climate change scenarios, so they may not effectively address climate impacts on the sector. The capacity of extension staff and farmers to address climate change impacts is limited (Patrick et al., 2020). In 3R Kenya, we have collaborated with some county governments to build capacity to design policy taking into account climate change scenarios, the Climate Atlas (<http://www.climate-atlas.ke>) and story maps. The Kenya Climate Atlas can support farmers and policymakers to move towards climate smart agriculture by providing information on expected climate change effects.

#### *Trade policies*

Mbuthia (2019) interviewed SMEs in the horticulture actor and found that entrepreneurs experience only weak institutional arrangements to help them access the export market. Complex export regulations restrict entry by SMEs to export markets. This shows that there are uneven market opportunities for SMEs compared to large companies that have adequate resources for this market.

### **9. Sector dialogue, coordination, MSPs & 11. Sector learning**

The horticulture sector is served by multiple platforms at different levels that seek to contribute to sector growth. They are initiated by different organisations. To secure food safety, the GlobalG.A.P. makes use of the National Technical Working Group for Horticulture to support the local use of GlobalG.A.P. standards. The Fresh Produce Exporters Associations of Kenya (FPEAK) also focuses on the use of certification and standards.

Private sector platforms that seek to enhance the performance of the private sector at national level include the Kenya Horticultural Council, FPEAK, the African Women Agribusiness Network and the Kenya National Farmers Federation. There is also the Horticulture Competent Authority Structure, as well as market-based platforms that rally around terminal markets or specific supply chains.

Agencies of the central government – including HCD under AFA, KALRO, KEPHIS and PCPB – are also important platforms supporting the sector at national level, with various programmes that contribute towards horticulture. Agricultural universities also support the sector.

Furthermore, development actors have created a number of programme-based platforms, including HortIMPACT, Kenya Horticultural Competitiveness Project, Smart Water for Agriculture Irrigation and Innovation and Kenya Agricultural Value Chain Enterprises (Matui et al., 2016).

However, the sustainability of the platforms is an issue as they are usually established and supported by donor funding or public funding. We have observed that some platforms stop being active as soon as funding stops (Essendi et al., 2018). Whether they continue afterwards to have a learning function remains questionable. We have also observed that many platforms serve the export segment of the sector, while the domestic market lacks overarching coordination and wholesalers/traders being the only segment that has associations with the markets (Gema et al., 2018; Matui et al., 2016).

We have also observed that the platforms are mainly nationally organised, but local platforms could also support sector growth. Informal market coordination at the county level is limited to the collection of duties (Gema et al., 2018). One county-level example is the National Potato Council of Kenya, which has recently established public/private potato platforms in six counties.

### **10. Sector finance and investment potential**

The financial characteristics of Kenyan agribusiness have been described as “non-uniform cash flows, rural bias, poorly capitalized and widely dispersed producers, seasonal cash flows, price and market risks [mean that it] differs substantially from businesses conventionally supported by traditional finance and microfinance” (FSD Kenya, 2009, p. 2; Wattel & Savelkous, 2018). Horticultural production is capital-intensive, especially because the right inputs are needed at the right time to get good results. The ability to purchase certified seed, fertilisers and pesticides and access to credit

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determine production investment decisions and product quality (Gema et al., 2018). These sectoral characteristics affect the supply of financial support. Only few banks and microfinance institutions invest in agribusiness, and the financial products offered do not always match sector realities. Credit products for short-term loans have impossible repayment schedules (Wattel & Savelkous, 2018). Farmers are reluctant to take on financial debt, as most do not want to use their land as collateral. Farmers who use low-cost production methods have no market guarantee (Wattel & Savelkous, 2018). This is evident by 47% of GLOBALG.A.P.-certified farmers and 69% of non-certified farmers reporting no need for credit. Of those who applied for credit (53% of certified and 21% of non-certified) only 29% of certified and 28% of non-certified were able to access it. Both categories of farmers rely on informal credit sources, mainly merry-go-rounds in farmer groups. Formal sources include banks and mobile money platforms.

Apart from private finance, we observe that the domestic horticulture sector remains reliant on public finance for its development, with finance from bilateral and multilateral development agencies playing a critical role (Advance, 2019). We have also concluded that cost are often dealt with using informal finance mechanisms, such as in-kind investment, employing family and friends and relying on money from family and friends. Furthermore, value chain actors can decide to improve payment conditions, and therefore reduce financial risks and improve farmers' cash flow (Wattel & Savelkous, 2018).

Long-term investment in the sector is often for infrastructure such as irrigation systems or greenhouses; for farmers, this is usually signals a move to commercial farming (Wattel & Savelkous, 2018). Specific investment for building a climate-resilient horticulture sector can be sought through the National Adaptation Fund and the Green Climate Fund (Patrick et al., 2020). 3R Kenya studies explored the impact of climate change on the investment potential of the horticulture sector, finding that it is likely to be affected by reduced yield and quality, yield damage due to water scarcity and flooding and risk of eutrophication. The incidence of pests and diseases is also expected to increase due to climate change. Productivity may be lower than expected, and production will become more uncertain (van Duijn, 2018).

## C. Innovation system

### 12. R&D and innovation

Research for the horticulture sector is mainly carried out at KALRO, which has the Horticulture Research institute. However, there are concerns that much research does not result in innovation. This is partly explained by the lack of collaboration between the research and private sectors. Therefore, KALRO has embedded demand-driven research into its mission. A Nuffic-sponsored NICHE project worked with KALRO on improving demand-driven horticulture training to contribute effectively to commercialisation, but the pilot has been affected by slow decision-making (pers. comm. I Koomen, project leader, 19 Feb 2020).

3R Kenya has also researched innovation in food safety traceability. Kenya has been investing in traceability systems, both private and public. The 3R study found three systems to be commercially available in Kenya: ePROD, Farmforce and the national Horticulture Traceability System (HTS) (Chemeltorit et al., 2018). ePROD was more suitable for the domestic market, but still does not completely satisfy the needs of the sector (Gema et al., 2020). HTS initiated a pilot, but most companies dropped out quite soon after it began. Long-term traceability innovations, if public-led like the HTS, must be accompanied by good product testing in the domestic market. The potential for scaling depends on the conditions, notably the cost of acquiring the innovations needs to be low; good support for learning how to use them is needed, and implementation needs to be voluntary and driven by the supply chain.

## Final values categories

### *Food and nutrition security*

Because horticulture productivity is improving, the sector is significantly contributing to food and nutrition security and more attention being paid to how FFV are adding micronutrients to Kenyan diets (Matui et al., 2016). FFV consumption is only 50% of the FAO/WHO recommended amount for the

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poorest consumers and 68% of the wealthiest consumers (Ayieko et al., 2005). For example, FFV are sold in very small amounts in Kibera slum, and little diversity is available (J Gema [Managing Director, Tradecare Africa] 2020, pers. comm. 18 Feb 2020). Increasing the diversity on offer can result in considerably improved nutrition for the poorest consumers. The developments in food safety standards and policies also contribute to provision of healthier food.

#### *Employment and job creation*

In 2014, over six million people across Kenya had jobs in the horticulture sector (i.e. production, processing and marketing). Another 3.5 million people are believed to benefit indirectly through trade and other associated activities. Based on MAGNET modelling results (Helming et al., 2018), it is expected that the sector will require even more labour, both skilled and unskilled; in other words, employment will significantly increase. The horticulture sector, particularly food processing SMEs, currently have a short supply of qualified workers in the food technology department (Mbuthia, 2019) and the rising demand for premium products cannot be met. Increased employment can only be assured with new investment, which is limited due to lower and stagnating profitability in the sector and high initial investment costs. However, households that are connected to the horticulture value chain, and specifically export horticulture, are overall better off than those that are not (McCulloch & Ota, 2002).

#### *Inclusiveness*

There is substantial concentration of women and youth at various stages of the value chain; youth constitute two-thirds of the labour force but are the most affected by low labour productivity. The majority of horticultural farmers are women, but they often do not own the land they are farming. There is still effort needed to enhance inclusiveness in the sector.

Clear policies to promote gender and youth inclusion are still needed in horticulture, as the national policies are not really tailored for the sector. While the laws surrounding inheritance, for example, are changing, ownership practices for family land are cultural; change is not yet occurring at the pace needed to push the sector towards higher inclusiveness (Matui, 2016). Various donor project (HortIMPACT) and social enterprises (HORTIGREEN) focus on inclusive development in the sector, but mainstreaming is not common. 3R Kenya developed an inclusive trade scan to support investors such as governments, donors and NGOs to foster inclusivity in their projects. The scan also helps companies seek more conducive market conditions to build the inclusiveness in their business (Guijt et al., 2019).

#### *Environmental sustainability and climate resilience*

Extension services, policies and technologies are the main drivers for a more sustainable horticulture sector, and initial efforts seem to be fostering environmental sustainability. Impacts come from nutrient run-off and its effect on water quality and pollinator diversity (van Duijn, 2018; van der Valk et al., 2013). The sector is vulnerable to the effects of climate change, as seasonal rainfall patterns are changing, severe weather events such as droughts and floods are becoming more frequent, and increasing temperatures make areas unsuitable for some crops (Patrick et al., 2020). The national government and some county governments are developing policies to support the horticulture sector to become more sustainable and more climate-resilient. Kiambu and Kajiado are piloting the use of the Kenya Climate Atlas (<http://www.climate-atlas.ke>), which is being developed jointly with the Kenya meteorological department, Jomo Kenyatta University of Agriculture and Technology and development partners so they can base their horticulture investments on realistic scenarios for their localities (van Selm et al., 2020). 3R Kenya has also studied resource efficiency, particularly how greenhouse use affects harvest losses for tomato crops. Ayuya et al. (2019) found that pre-harvest losses are much lower in greenhouses compared to in the open field, because pre-harvest losses are mainly due to pests and diseases. However, post-harvest losses are similar for tomatoes produce in fields and greenhouses because these losses are due to poor quality of tomatoes and grading.



## Appendix 2 Framework to assess 3R sectors transformation

Components (3) and systemic issues (12)	Characteristics of GOOD situation (= level 4)	Score current situation (1)	Score on trends (2)	Evidence, examples (3)
<b>A. Integrated food supply chain systems (Robust)</b>				
1. <i>Markets and demand for sustainable and inclusive products</i>	<ul style="list-style-type: none"> <li>mainstream market demand for sustainably produced products (replacing less sustainable), based on well-informed consumers</li> <li>market does not exclude smallholders or the poor</li> <li>diverse products may be available</li> <li>relevant for domestic, regional and export markets</li> <li>operates at scale</li> </ul>			
2. <i>Viable technologies, production / processing systems</i>	<ul style="list-style-type: none"> <li>widespread use of sustainable, inclusive and resilient production and processing practices and systems</li> <li>production systems have quality and volume to meet market demand</li> <li>good mix of different production systems and post-harvest practices</li> <li>sufficient mechanisation</li> </ul>			
3. <i>Empowered producers and producer organisations</i>	<ul style="list-style-type: none"> <li>producers or organisation models (e.g. outgrower, contract farmers, cooperatives)</li> <li>effectively organised around production, service delivery, market access and agency at sector level</li> <li>key capacities include governance, entrepreneurship and management capabilities</li> </ul>			
4. <i>Value chain relationships and contract models</i>	<ul style="list-style-type: none"> <li>development of efficient and fair value chain relations</li> <li>key elements include transparency and traceability, fair pricing and trading practices, sufficient ownership for producers</li> <li>operates at scale</li> </ul>			
5. <i>Supportive services, finance</i>	<ul style="list-style-type: none"> <li>high-quality and differentiated services to producers and value chain actors</li> <li>accessible to different social groups</li> <li>services includes access to knowledge, inputs and finance</li> <li>can be provided by public, private agencies and/or NGOs</li> <li>operate at scale</li> </ul>			
6. <i>Viability of business models</i>	<ul style="list-style-type: none"> <li>commercial viability of new business models, supported by a clear business case (i.e. with positive impact and benefits for the 'owner')</li> <li>business models applicable to all supply chain actors, e.g. input providers, cold chain, etc.</li> <li>the best models being copied</li> </ul>			
7. <i>Supportive infrastructure</i>	<ul style="list-style-type: none"> <li>supporting public services are present and function properly (water, electricity, roads, education, cold chain)</li> <li>accessible to all producer groups</li> </ul>			

Components (3) and systemic issues (12)	Characteristics of GOOD situation (= level 4)	Score current situation (1)	Score on trends (2)	Evidence, examples (3)
<b>B. Institutional governance (Reliable)</b>				
8. <i>Enabling policies, regulations and implementation:</i> a. Food safety b. Climate change c. Markets and trade d. Sustainability and inclusiveness e. Multi-level governance coherence	<ul style="list-style-type: none"> <li>• policies and regulations allow mainstreaming of sustainable business models and fair trading relations, and their effective implementation at scale</li> <li>• "multi-scale" includes national and county levels</li> </ul>			
9. <i>Dialogue and coordination, MSPs</i>	<ul style="list-style-type: none"> <li>• sector with functioning formal or informal multi-stakeholder platforms and / or governing bodies</li> <li>• vision and strategy for the sector</li> <li>• shared standards and guidelines</li> <li>• informed policymaking</li> <li>• key stakeholders have a voice</li> </ul>			
10. <i>Sector finance and investment potential</i>	<ul style="list-style-type: none"> <li>• revenue generated at sector level and re-invested into the sector</li> <li>• both formal (e.g. taxes, fees) and informal revenue generation mechanisms</li> <li>• re-investment mechanisms (e.g. subsidies, trust-funds, loans) and innovation mechanisms</li> </ul>			
<b>C. Innovation systems (Resilient)</b>				
11. <i>Sector learning</i>	<ul style="list-style-type: none"> <li>• systems and networks are present</li> <li>• capacity to monitor and learn from evidence is accessible to all supply chain actors, with room for effective exchange</li> </ul>			
12. <i>R&amp;D and innovation</i>	<ul style="list-style-type: none"> <li>• education institutes (training), both public and private, are present</li> <li>• institutes are doing research in the sector</li> <li>• linkages exist between research and public and private implementing organisations</li> </ul>			

## Legend

### (1) Score current situation

1. Poor: None of the characteristics of good situation are met
2. Moderate: A few of the characteristics of good situation are met
3. Fair: Most of the characteristics of good situation are met
4. Good: All characteristics of good situation are met, and at scale

### (2) Score on trends during the last 3–5 years

- Positive: Positive changes  
Neutral: No changes  
Negative: Negative changes  
??: Unknown

### (3) Score on contribution by 3R during the last 3–5 years

- Significant: Strong contribution to positive change  
Some: Some contribution to positive change  
None: No contribution to changes  
??: Unknown

### (4) Evidence and examples – to be documented separately / not in this table

Note the main pieces of evidence, being the excel file, documentation, or short bullet words of major events or factors.

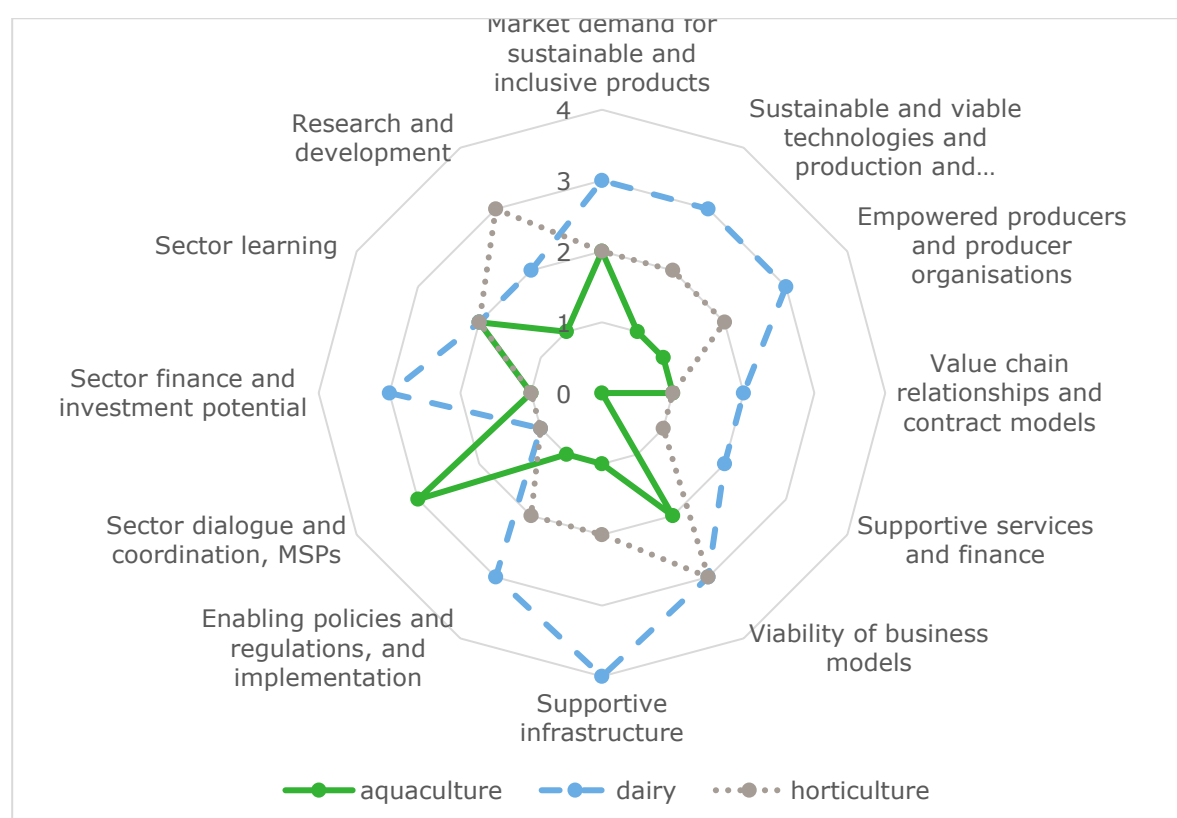


## Appendix 3 Spiderweb diagrams showing the current state of the sector transformation

We use the spiderweb schemes to provide an easy and qualitative overview of the level of transformation of each sector based on the scores for the current situation for each of the 12 systemic issues. It should be kept in mind that these are expert perceptions and opinions. The spiderwebs are useful because they make comparison between sectors easier, by revealing sectoral differences. For instance, the systemic issue “policies and regulations” scores 1 for aquaculture, 3 for dairy and 2 for horticulture. The evidence for each of the systemic issues is provided in Chapter 3.

The spiderwebs make clear that the dairy sector has the highest score on transformation for the 12 systemic issues (average score 2.6), followed by horticulture (1.8) and aquaculture (average score 1.3). However, the individual systemic issues often show strong variation between the three sectors, with some systemic issues scoring better than others.

The trends of the changes are not illustrated in the spider diagrams but are discussed in the descriptions for each sector (Appendix 1) and for systemic issues in Chapter 3. However, it appeared from the analysis that for all sectors and for most systemic issues the trend of changes since 2015 has been positive. Yet some systemic issues do not show any change (e.g. business model, value chain relations, policies), and negative trends were observed for the environmental impacts of production systems and for food safety issues in horticulture.



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