

A close-up photograph of a hand holding a stalk of wheat. The background is a vast field of wheat under a bright, low sun, creating a warm, golden glow and lens flare effects. The sun is positioned behind the hand, casting light through the fingers.

Building a smarter food system

*More productive, connected
and sustainable*



Building a smarter food system

Global food & agribusiness (F&A) has much to do: it needs to increase food availability, improve access to food, ensure balanced nutrition and stabilise the global food system. This expansion is further complicated in markets where clear growth signals have given way to the more subtle, but equally powerful trends of urbanisation and modified consumer behaviour.

The recently adopted 2030 Agenda for Sustainable Development sets clear global goals for ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture. It will require ambitious action across global F&A. Action, in turn, requires investment that is targeted and well managed, so farmers, F&A companies and others that are taking the required measures and associated risks receive acceptable returns on their investments.

Rabobank has great confidence in global F&A; we believe it has the capacity to meet these goals and projected demands. While we foresee production increases in crops, meat and fish, and dairy across all regions—especially in those least constrained by resources and external pressures—we believe the nature of food production and distribution can and should change.

In Rabobank's view, transition to a smarter food system will provide an opportunity to realise many of the necessary gains.

A smarter food system is more productive, more (globally) integrated, less wasteful and more profitable. It is more efficient in using resources to produce and deliver the food consumers need, where and when they need and want it, making it more sustainable.

A smarter food system combines technology and (big) data, and uses algorithms to change the way decisions are made and the speed with which decisions are taken—in food production, processing and distribution. By greatly improving supply chain connections, it offers scope to lift food production, optimise the use of resources, reduce waste and improve access to food. It should also improve stability in the global food system, encouraging investors along supply chains.

The road ahead will be bumpy, and full of climatic and other challenges. A key issue will be to engage—to communicate with society about the meaning and consequences of feeding 9 billion people in a sustainable way in 2050.

At Rabobank, we are excited about the prospects offered by building a smarter food system, and we invite you to join us on a journey to discover what exactly a smarter food system means and what it can offer.

Berry Marttin

Member of the Executive Board, Rabobank



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Our food system needs to be
smarter. Let's build it.



Pressure is mounting on the global food system. We need to:

- 1. Improve resource **efficiency***
- 2. Better meet consumer **expectations***
- 3. Improve **profitability***
- 4. Improve **resilience***

Change is inevitable. The combined need to improve resource efficiency and profitability, as well as the need for increased food availability, signals the direction of change.

We need improved outcomes from the global food system:

- 1. Increase food **availability***
- 2. Improve **access** to food*
- 3. Stimulate balanced **nutrition***
- 4. Enhance system **stability***

The global food system needs to change

The current system—successful in many ways—needs to achieve even more, while, at the same time, pressure on the system is growing from four major drivers.

We need to focus on boosting productivity

Growth in production needed to meet future demand will increasingly depend on lifting yields, and technology and data will have an important role in realising this.



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Future global crop production:

Yield increases and cropping intensity will become even more important

	1961-2007	2005/07-2050f
Arable land expansion	14%	10%
Increases in cropping intensity	9%	10%
Yield increases	77%	80%

“Intensification—higher yields and more intensive use of land—needs to contribute 90% of the growth in global crop production to 2050.”

United Nations Food and Agriculture Organization, 2012

Future global meat production:

Productivity gains become more important than increases in animal numbers

		1961/63	2005/07	2050f
Number of animals (millions)	Cattle	1,045	1,532	2,032
	Pigs	424	917	1,141
	Poultry	4,435	19,160	37,030
Carcass weight (kg per animal)	Cattle	158	200	227
	Pigs	65	79	84
	Poultry	1.3	1.6	1.7

“Higher productivity—combining higher offtake rates and higher carcass weights—will become more important in meeting global livestock and dairy production needs to 2050.”

United Nations Food and Agriculture Organization, 2012



Technology

The combination of technology, big data and algorithms is a potentially powerful opportunity to improve outcomes in the global food system.

Technology automates the way things happen.

Big data tells us what is happening.

Algorithms translate that data into decisions, adding speed and accuracy to food production, processing and distribution.

Big Data

Algorithms

A smarter food system can
deliver what we need

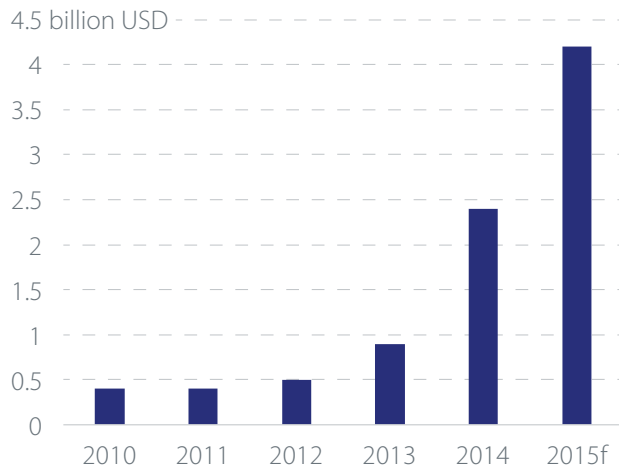
A smarter food system is more productive, less wasteful and more profitable. It uses resources more efficiently to produce and deliver food where and when it is needed.

We're starting to move to a smarter food system

Investors have started to back this trend as three sweet spots emerge: farming, processing and food logistics.

Building a smarter food system is of increasing interest to investors—as evidenced by new deal flow activity

Investments in smarter food system start-ups—impressive though they are—are just a part of the story. New deal flow activity does not capture the sizeable investments being made by existing F&A companies, which are focused in three sweet spots.



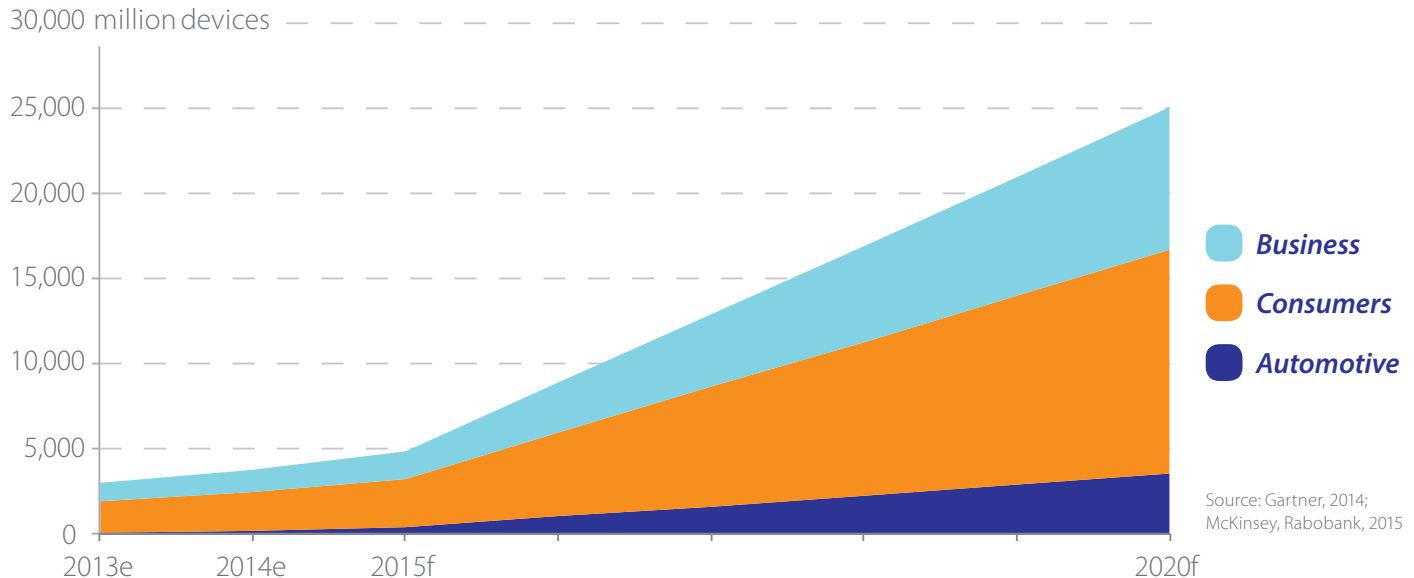
Source: AgFunder, Rabobank, 2015



The base for a smarter food system is rapidly expanding

The world is fast becoming even more connected, and these connections can be harnessed as a force for positive change in global F&A.

Growth projections for the 'Internet of Things' highlight the potential—across all facets of society and industry—especially if innovators use this connectivity to create new business models, rather than simply digitising existing processes



Examples of a smarter food system in the works

Around the world and along supply chains

Building a smarter food system is about making the incremental gains that lift availability and improve access across the global food system.

Boosting productivity and reducing wastes are fundamental building blocks in global F&A—they improve profitability and encourage ongoing investment.

Integrating (big) data into decision-making and other business processes in real time is a common challenge across the many case studies and development areas we have reviewed.



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Everyone can gain from a smarter food system

Gains are available along supply chains and across sectors in global F&A.



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Farm Inputs

Phenomics are speeding up innovation:
enabling two- to sixfold productivity gains

Farming

Drones take farming to new heights: lifting productivity by 5% above business-as-usual

Smart irrigation helps us to use water effectively: reducing water use by as much as 80%

Processing

Fresh produce monitoring can lift quality and reduce waste:
Fruit and vegetable losses and waste can be reduced by 25%-40%

Distribution

Retail

Poultry production and processing gets connected:
lifting productivity by 5% above business-as-usual

The data cooperative is coming:

Harnessing big data can create some USD 10 billion of value at crop farms worldwide, each year

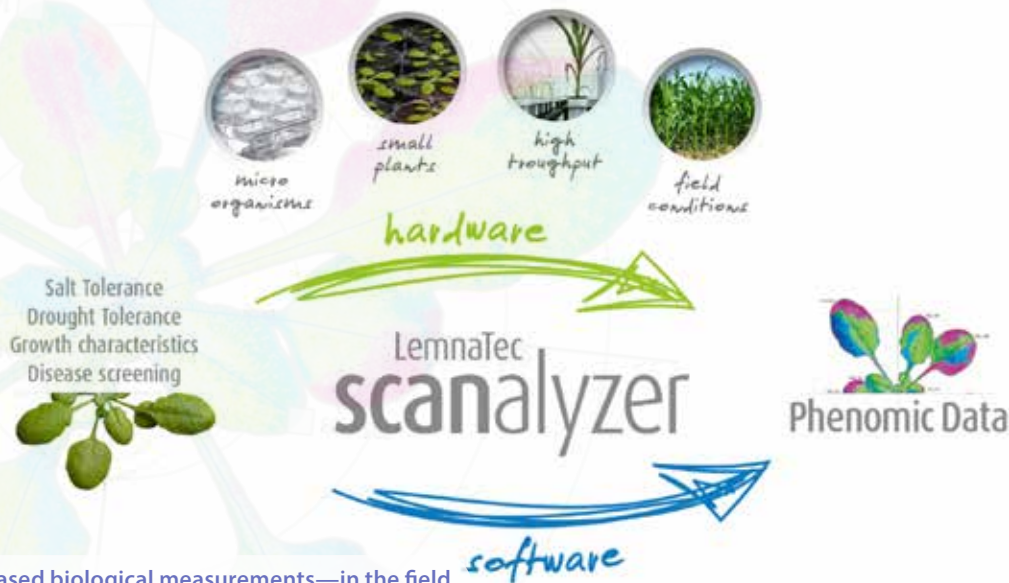
Big data helps food retailers create customer value: Retailers are looking to recover margins of at least 1%

Phenomics are speeding up innovation

A smarter system can identify beneficial traits in seedlings and plants quickly and accurately, accelerating the production of new hybrids. New hybrids boost productivity and profitability.

Automated phenotyping offers multiple benefits over traditional human measurements—two- to sixfold productivity gains are possible:

- Increased speed and accuracy
- Reduced cost
- Shorter timeframe to introduce new varieties
- Improved fit between trials and field uses



LemnaTec's technology takes image-based biological measurements—in the field, glasshouse or laboratory—and analyses the data to accelerate the identification of desirable traits in seedlings and plants. Drought and salt tolerance, and disease resistance are just a few examples.

Seed development and production enhance the integration along supply chains—seed companies can link more closely with seed multipliers and customers.

Drones take farming to new heights

Remote technologies, such as drones, show great potential to reduce operating costs and increase productivity. Tech-savvy farmers and growers in areas with strong connectivity are already benefiting.

Boosting livestock productivity:

A livestock farm in New Zealand has identified some 40 applications for drone and sensor technology that are linked to the farm office.

This has delivered:

- a large reduction in farm machinery running costs
- a 14% reduction in stock losses
- a 50% reduction in deaths of cast sheep

Analysing daily grass growth is the next goal—this information could help increase lamb production and, in the process, boost income by some USD 200/hectare.

Not a drone deal... at least not yet

- Drones and aerial sensors are a work in progress.
- System reliability, algorithms that generate actionable advice, and real-time decision-making at scale are just some of the challenges to implementation.

Source: Neil and Pip Gardyne, Noukatech, Rabobank, 2015

Boosting horticulture productivity:

Noukatech provides a drone-based mapping solution for US specialty crops, such as vineyards and citrus farms.

Drone-mounted sensors collect data on crop conditions. Algorithms translate data into targeted grower actions, such as nutrient applications, irrigation and harvesting schedules, as well as product marketing. The system boosts productivity through:

- Improved accuracy on crop conditions
- Less time spent surveying crops
- More targeted and efficient application of inputs
- Better prices for extra produce

Productivity gains of the order of 5% above business-as-usual gains are achievable—through reduced inputs, targeted interventions and increased output



Smart farming systems improve the efficiency of water and chemicals use—by as much as 80%:

- *Variable rate irrigation—with pivots linked to GPS and field data—delivers water use efficiency gains.*
- *Plant and soil data sensors provide real-time information to inform variable rate delivery, saving water.*
- *New spray systems and soil treatments optimise the delivery of water and chemicals, reducing inputs.*

Smart irrigation helps us to use water effectively

Current rates of global agricultural water demand are unsustainable. The efficiency of water and chemicals use can improve—by targeting what water is needed, and when and how inputs are applied.



Yara's ZIM probe measures a plant's water stress to enable irrigation on demand



Tule sensor systems provide field data to inform irrigation needs



On Target spray systems apply an electrical charge to create a fine mist of droplets that is delivered into the plant's canopy

Source: United Nations World Water Development Report, On Target, mOasis, Tule, Yara, Rabobank, 2015

Smart irrigation systems improve the efficiency and effectiveness of water, nutrients and chemicals delivery to crops. They vary the applied rates, the timing of application and even the method of delivery in order to better meet crop needs.

The data cooperative is coming

Smarter crop farming—driven by big data, precision-farming equipment and algorithms—offers significant scope for boosting productivity. Farmers, suppliers and their customers need new relationships to build scale by sharing data and expertise.

Smarter crop farming can create some USD 10 billion of value at crop farms worldwide, each year

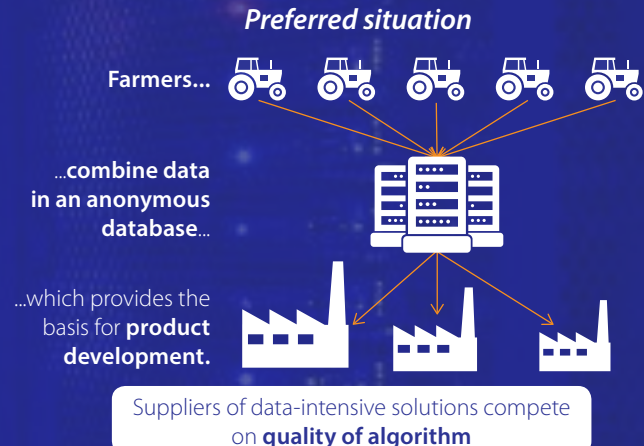
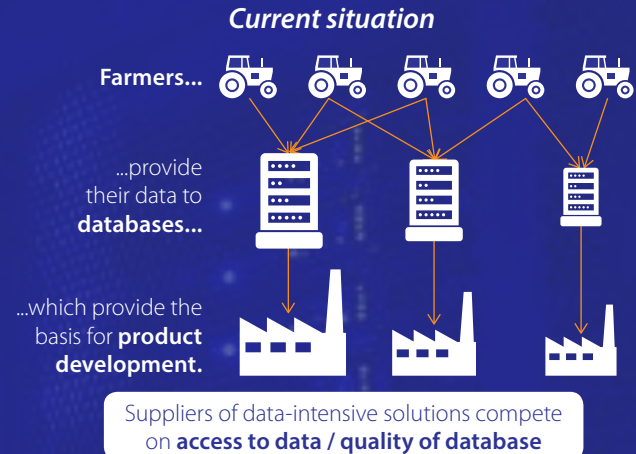
Value creation depends on data that enables a transformation from **intuitive** to more accurate and precise **fact-based decisions**

This data needs to be generated through **data aggregation**

Data in a farmer-owned data cooperative creates a **level playing field** for those that develop data-intensive solutions for farmers

Data cooperatives can also provide peer data, increase market transparency and support farmers' marketing decisions

Source: Rabobank, 2015



Poultry production and processing gets connected

Increasing control over poultry hatching, production and processing—using online sensors that deliver data to remote control centres that respond in real-time—can boost productivity and profitability.

Optimising production:

- Improved monitoring at hatcheries improves feed efficiency and reduces the need for animal health inputs.
- Automated feeding systems respond to **real-time data** on flock demand.
- Indoor air quality sensors linked to control systems enable responses to heat and air quality stresses in real-time.
- Individual birds can be identified by sensor devices, facilitating **targeted health interventions** rather than flock-based approaches.



Smarter poultry production and processing could achieve productivity gains of up to 5% above business-as-usual.

Optimising system performance:

- Processors can monitor the performance of poultry farmers, providing guidance on potential productivity and welfare gains.



Optimising distribution and consumer information:

- Sensors in trucks enable remote monitoring of stress and welfare.
- Consumers can download the story of their chicken, using QR codes affixed in processing.



Source: University of Cambridge/Zoetis, Jackman/University College Dublin, Metabolic Robots, Rabobank; 2015

Fresh produce monitoring can lift quality and reduce waste

Fresh produce growers, processors, distributors and retailers can reap significant gains through the active monitoring of fruit and vegetables along supply chains.

Improved decision-making based on quality measured by smart sensors reduces waste by 25%-40% in F&A supply chains

Radio frequency identification (RFID) tagging has long been used for high-value non-food products, and its potential is crossing over into fresh produce, helping to improve the tracking of shelf life and quality of fresh produce.

The cost of RFID tags is coming down, making them an affordable option for fresh produce retailers and distributors.

Cooperatives and distributors will make this technology accessible in emerging markets, while food retailers will be the drivers in developed markets.

Enhancing fresh produce in emerging markets

RFID monitoring can improve production and processing in emerging markets. Big data can calculate the optimal time between harvest and processing, and can reduce the costs of inspection and manual monitoring.



Primary processing of bananas and inspection



Dynamic pricing at the supermarket

Enhancing fresh produce in developed markets

RFID monitoring can be used by retailers to improve the prediction of shelf life and, hence, quality. It also enables them to adjust pricing based on quality and shelf life. Pilots at retailers have shown that quality-steered pricing increases sales of fresh produce categories, while requiring less inventory.

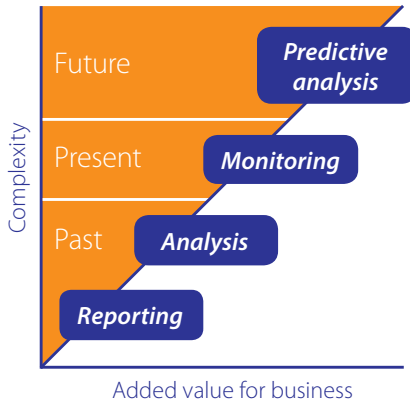
Big data helps food retailers create customer value

Retailers have access to vast amounts of consumer and other data, and leading retailers are finding new ways to create value from this data by optimising inventories and targeting assortments to customer preferences.

Food retailers are embracing big data as a source of value creation and are seeking to at least recover margins of 1% in the process.

Better predicting customer needs is a new driver of competitiveness. It can:

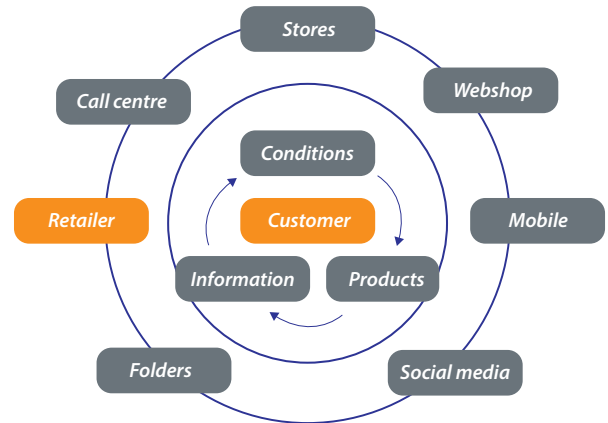
- *Sharpen the customer value proposition*
- *Develop a more distinctive position*
- *Generate new income by selling customer data to suppliers*



Integrating formats and channels to meet customer needs

It's an omni-channel world:

Customers want retailers to provide the same products, information and conditions—anywhere and anytime



Walmart: using big data to better meet customer needs

Analysing customer and weather data optimises ordering and inventory, for distributors and retailers. For example:

- Ideal berry weather: temp. <27°C, with low winds.
- People eat more steak when it's warm and windy, but not raining.
- Ground beef and salads excel at higher temps, with low wind and sunny conditions.



Source: Walmart, Rabobank, 2015

What it will take



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Three keys to building a smarter food system



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The diversity of examples and the scale of productivity gains they can deliver demonstrates what is possible by building a smarter food system. But just because it is possible doesn't mean it will be easy. Specific actions are needed to manage risks and secure investments in building a smarter food system.

Strengthen supply chains

- *In building a smarter food system, buyers and suppliers are taking on new risks in pursuit of new rewards.*
- *Strong supply chains are needed to share risk and reward between buyers and suppliers along the chain.*
- *Success depends on greater connectivity between buyers and suppliers, sharing data and making joint decisions in real time.*

Enable investment

- *New approaches and new technologies entail new areas of risk and opportunity.*
- *Investors and financiers need to back new projects, with appropriate mechanisms to manage risk and secure relevant risk-adjusted returns.*
- *Accelerating the commercialisation of new technologies, data capture and decision-making algorithms is particularly important.*

Achieve societal acceptance

- *Consumers tend to favour simplicity when it comes to food production, but simple approaches will not deliver all of the change that is needed in the global food system.*
- *It is important that any concerns consumers may have around change in the food system are understood and taken into account in the change process.*
- *In some cases, issues are not 'black-and-white' for consumers, and informed decisions require higher levels of engagement and education.*

The case for strengthening F&A supply chains

F&A companies face relentless pressure on supply chains. Successful responses require a shift in focus—from chasing price to adding value—and action in four growth areas.



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There are many reasons for strengthening supply chains—building a smarter food system is just one of them. A stronger supply chain provides the basis for suppliers and buyers to manage pressures and to find growth. Focusing on innovation is one important growth area.

*Focus on delivering innovation
as the litmus test for strong
buyer-supplier relationships*

*Optimise inventory management
so all partners contribute to and
benefit from growth*

*Improve routes to market
to get closer to buyers and consumer
preferences*

*Manage complexity
as supply chains shift from simple lines
to more complex webs*

Source: Rabobank, 2015

The best relationships are built on innovation

Collaborative supply chain relationships facilitate innovation—to reduce risk and production costs, and access new markets. If buyers and suppliers see value in working together, they will invest in innovation for mutual gain.

Buyers consistently say they depend on their suppliers to deliver innovation. So who is waiting for whom?

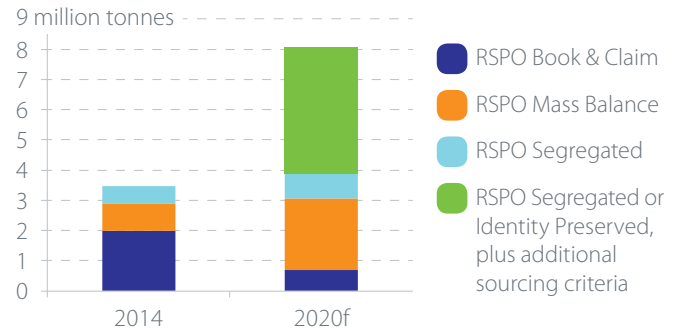
According to recent surveys of supply chain managers:

- 80% of companies are adopting collaborative business models with suppliers and customers to improve speed-to-market and lower innovation costs.
- 70% of companies see innovation as a critical path to growth.
- 60% of top companies are looking for suppliers to introduce new ideas and innovative thinking.
- 40% of top companies list supplier innovation among their top two business priorities.

The sharing of risk and reward along strong supply chains is an important pre-condition to increasing the focus on innovation. Buyers often control the sharing of risk and reward, so can readily signal the need for innovation to suppliers.

Innovation is needed to access growth markets—for example, most growth in palm oil trade will be for certified and traceable supply

The Roundtable on Sustainable Palm Oil (RSPO) offers multiple approaches to certification, with varying degrees of chain control.



The trend to 2020 is for palm oil sourcing by branded food and personal care companies to focus on increasing supply chain control, which depends on innovation between buyers and suppliers.

Building a smarter food system will need investment

New approaches require investment to capitalise on the opportunities. Investors are looking for an acceptable risk-adjusted return.

Investment and finance is needed in the three elements of a smarter food system:

Technology

Big Data

Algorithms

- *Investment may be through established farms, farm machinery companies, food processors and manufacturers, and logistics providers.*
- *Investment may also be through 'start-up' companies looking to commercialise a disruptive change, process or technology.*
- *Finance is needed to support implementation, which can also carry significant risk.*

Investors and financiers supporting a smarter food system need to manage risks in order to secure finance:

Technology

Will the new technology, data capture and algorithms work as intended?

Market

Will the smarter food system be able to compete in the market and generate adequate returns?

Business

Can the technology, data and algorithms be implemented as intended and integrated into current business systems?

Regulatory

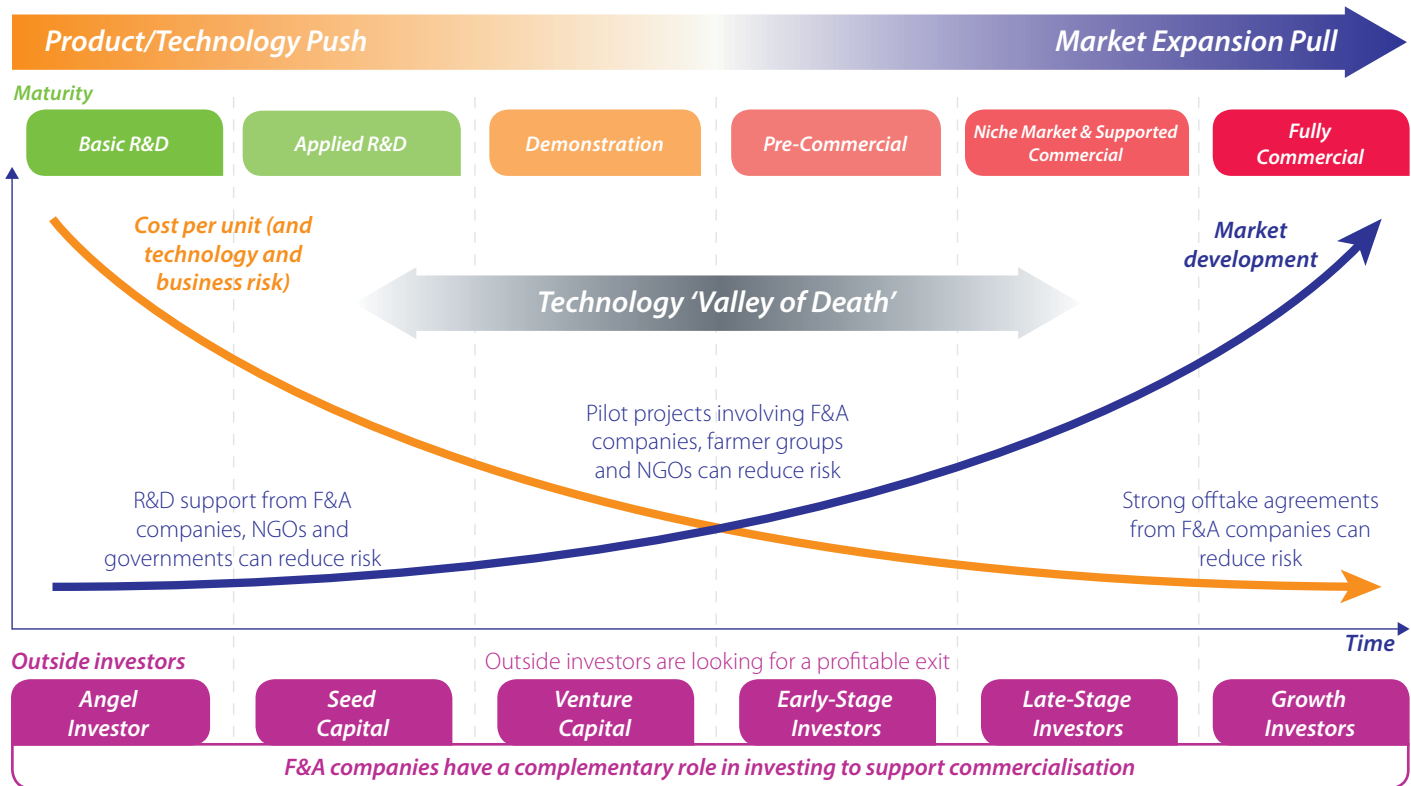
Does the smarter food system fit within current regulatory boundaries?

Reputational

Will the new approach raise public concern?

Market forces are essential to commercialising technologies

As new technologies mature, they depend on the pull of market forces towards commercialisation. Many can get lost in a 'valley of death' as market forces elude them, unless steps are taken to reduce risk.



Societal dilemmas and acceptance

The idea of small-scale, 'natural' farming is inherently appealing, but is not the reality of modern farming in much of the world. In order to feed the world efficiently, change is needed, and society's concerns also need to be taken into account. We cannot build a smarter food system, enhancing sustainability in the process, without public support.

Food waste

“They say we already produce enough food to feed the world, but losses and wastes prevent food from reaching everyone who needs it. How can this be? What should governments do to reduce waste? What about companies, and even us as consumers?”

Nutrition

“In developed countries, we eat too much fat and sugar, and we are facing big public health costs as a result. Should governments set limits on sugar and fat levels in food? Can the companies self-regulate, or do we use our own judgment as to what we eat and drink?”

Genetic modification and cloning

“Do we really need all technology options to improve sustainability in how we feed the world, or do some technologies cross a line? How do we decide where that line is set?”

Animal welfare

“We accept it's OK to rear animals as human food, but animals need to be treated humanely. How do we set scientifically-based standards that also meet our expectations of humane treatment?”

Who owns my big data?

“We understand that big data and analytics offer scope to improve productivity in global F&A. But who owns the data, and what can they do with it? There's a lot I don't really know here, but I think I want to keep my data private.”

Conclusions



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Improving productivity, connectivity and sustainability

A smarter food system offers enormous scope to improve the productivity of global food production.

Productivity gains of at least 5% are within reach across a number of sub-sectors, supply chain stages and regions.

These gains may not appear spectacular when viewed as isolated cases, but once they are scaled up and rolled out across global F&A, the magnitude of potential change is transformational.

Change of this scope is not going to be straight-forward—Rabobank believes a focus in three areas will be key to success:

- **Build and strengthen trust** in relationships along supply chains. Buyers and suppliers need to accept change, embrace innovation and recognise this is best achieved working collaboratively.
- **Invest for long-term success.** We need investors who recognise the importance of 'market pull' in facilitating investment, appreciate the risks involved in change and are willing to invest in pursuing the opportunities.
- **Bringing society along for the journey.** Deeper engagement between global F&A and society—with open discussions and an exchange of perspectives—can lead to improved understanding on the need for and opportunities resulting from building a smarter food system.

Rabobank is positive about building a smarter food system—yet realistic about the risks and opportunities involved in this change process.

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Banking for Food is Rabobank's vision on global food security and the role of the bank. As a consequence of a growing and wealthier global population, the demand for food is expected to rise considerably. The food and agri value chains have to produce more with fewer natural resources. As a leading international food and agri bank, Rabobank aims to support and facilitate in meeting this challenge—by providing access to finance, knowledge, and networks to clients and their communities.



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