The Hague Centre for Strategic Studies

FUTURE CONTOURS OF AGRICULTURE & FOOD

A METAFORESIGHT STUDY

The Hague Centre for Strategic Studies

GLOBAL TRENDS

HCSS helps governments, non-governmental organizations and the private sector to understand the fast-changing environment and seeks to anticipate the challenges of the future with practical policy solutions and advice.

This report is from the HCSS theme GLOBAL TRENDS. Our other themes are SECURITY and RESOURCES.

GLOBAL TRENDS

HCSS explores the complex dynamics of a globalized world, and examines future developments of strategic importance. Where do these developments originate, how will they evolve over time, and how can they affect interests and decisions for governments, businesses, and citizens?

HCSS helps to understand global strategic trends, and to develop strategies aimed at building resilience against future shocks and uncertainties.

FUTURE CONTOURS OF AGRICULTURE & FOOD
The Hague Centre for Strategic Studies (HCSS)

ISBN/EAN: 978-94-92102-14-0

Authors and Contributors Eline Chivot, Willem Auping, Roberta Coelho, Freija van Duijne, Mayuri Mukherjee, João Almeida Silveira, Michelle Yuemin Yang

Graphic Design Studio Maartje de Sonnaville, The Hague

The Hague Centre for Strategic Studies

Lange Voorhout 16
2514 EE The Hague
The Netherlands

info@hcss.nl
HCSS.NL

FUTURE CONTOURS OF AGRICULTURE & FOOD

A METAFORESIGHT STUDY

The Hague Centre for Strategic Studies

TABLE OF CONTENTS

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Agriculture and food are central to the economic security for the Netherlands specifically, but also for the EU in a broader sense. Overall, both security of demand and supply are of vital importance for the economic security of the Dutch agriculture and food sector. The broader, long-term sustainability of Dutch agriculture is a key concern. And at the European level, the overall competitiveness of agriculture keeps playing an important role. We cannot ignore that the development of large economies – for example, the BRICs (i.e., Brazil, Russia, India, and China) – will continue to bring up serious challenges for the future of agriculture. For example, with their huge populations, these countries will thus substantially contribute to the increase of the global demand for meat.

Who will produce and eat tomorrow's food is a complex and uncertain issue. As a result, having a broad sense of thoughts about the future of agriculture is of utmost importance. It is simply impossible to keep thinking only from a Dutch or European perspective, especially as resource markets, including food, are becoming increasingly global.

We performed a research to find out how different countries, in the Chinese, English, and Portuguese language domains, as well as in Africa, are thinking about the future of agriculture. For this purpose, we used the HCSS MetaFore protocol as a methodology for the systemic coding of relevant government and think tank foresight studies about this topic. This study was performed as part of the project *Future Contours of Agriculture and Food*. It seeks to better inform decision makers from government and industry in preparing for the challenges of this future environment. It has a modular setup: the results presented here can be built upon in order to gain a better insight in the future nature of agriculture and food. More generally, they could provide supporting material to develop agricultural policies that would help both producers and consumers benefit from the fruits of sustainable food production, now and in the future.

The findings presented in this report should not be interpreted as a prediction of the future or comprehensive. We tried to capture the essence of a broad foresight discourse using our methodology. However, the inherent complexity and uncertainty of the future in all its dimensions, and that of geographical environments should not be ignored.

Working with a global, multilingual team, a collection of foresight studies in different 'language domains' or geographical zones was harvested, coded, visualized and analyzed. Our coding protocol combines the qualities of manual, human coding and automated coding. The approach tries to capture a broader bandwidth of views than is possible when one works within one, implicitly biased viewpoint. The coding process of weighting the different types of content that are mentioned in the reports helps to reveal the dominant themes in the foresight studies. It shows the way certain drivers of change are discussed, which stakeholders are involved and many other aspects of meaning that are important in these foresight studies. It also reveals the blind spots of themes that are discussed more in-depth in some language zones, but more or less ignored in other parts of the world. In this way, the meta-foresight study gives a multi-perspective approach.

The insights can be truly refreshing and may trigger deeper drill-downs into the riches of these multiple futures.

Regarding the findings of this study, perhaps unsurprisingly, all perspectives recognize the increasing risks and uncertainties in terms of agricultural production. Most countries are concerned with the challenge of achieving and strengthening sustainability in the agricultural domain – sustainability, in all its different dimensions: economic (e.g., market failure, risk of insufficient infrastructure or techniques, hindering production), political (such as insured by the continuity of policies and regulations), and environmental (e.g., the impact of increasingly frequent weather hazards on crops).

All views decidedly focus on the economic dimension of agriculture's future. Many of the selected players are mainly concerned with the challenge of increasing production to be able to face a growing global and national demand for commodities. Concerns are raised over the infrastructure that needs to be upgraded and the sustainability of production models. Brazil and India particularly mention the importance of increasing productivity levels. Maintaining positions and influence in global trade is one of the underlying objectives. Developing economies are aware that the agricultural sector is a major source of economic growth and employment.

In reaching these objectives, governments seem to have a key role, in order to reform, implement policies supporting the sector and protecting stakeholders (such as farmers). Yet private sector actors are set to have a large and growing influence – and would be indispensable in facing future challenges through investments and collaboration with public sector actors.

Human security is another key theme, drawing from environmental degradation, resource limitations and the disastrous impact of climate change on these exposed 'southern' regions, to food security in terms of health, quality, and supply (how to feed growing populations?). We should be prepared to face the consequences of demographic changes, including urbanization and population growth, and shifts in consumption patterns.

Overall, there is a consensus on the efficiency of a combined involvement of central governments and private sector actors in the future of agriculture. There are many discussions on agricultural modernization and transition. And it should be noted that good and reliable global governance and international cooperation are emphasized as supporting elements of the road towards agricultural sustainability, as well as the need to focus on knowledge generation through human capital development, research, technology, innovation and scientific progress.

The structure of the report is as follows. The first chapter is a broad introduction, followed by a second chapter that offers an in-depth description of the study's background and the methodology. The third and fourth chapters provide our assessments of prevailing views on the future nature of agriculture and food in the Chinese, English (for India), and Brazilian language domains, and in Africa as a geographical zone. These assessments are based on a selection and analysis of foresight studies, processed through a text mining tool (results in the third chapter), and manual coding (results in the fourth chapter). In the fifth chapter, we provide the main conclusions of this report.

Interested readers can request our Technical Report, which includes a more comprehensive version of the research, from the methodology to the most detailed findings, and the Annex, which provides the list of foresights per language domain and geographical zone.

1 INTRODUCTION

1 INTRODUCTION

Agriculture and food are central to the economic security for the Netherlands specifically, but also for the EU in a broader sense. The agricultural sector in the Netherlands accounted for around 2 billion of the trade surplus in 2013 – for a total surplus of 4.5 billion. Securing the demand for agricultural production is, therefore, an important issue for the Dutch. However, to maintain the competitive strength of the sector, the imports of necessary inputs such as soy and phosphate, are of vital importance. In addition, the Netherlands is both one of the global key agriculture exporters and an import trading hub for agricultural products in Europe and beyond. Overall, both security of demand and supply are of vital importance for the economic security of the Dutch agriculture and food sector, and the economy of the Netherlands in general for now and in the future.

The development of large economies – for example, the BRICs (i.e., Brazil, Russia, India, and China) – will continue to bring up challenges for the future of agriculture on a global scale. The demand for proteins, mostly meat, increases considerably when the GDP per capita develops from a low to a middle income. With their large populations, these countries will thus substantially contribute to the increase of the global demand for meat. Without a substantial rise in productivity of global animal husbandry (and its inputs), especially in the BRIC countries, it is difficult to see how this demand is going to be filled in.

The role of Africa in the future of agriculture could give rise to interesting developments. At present, agriculture in the poorly developed African economies is predominantly characterized by subsistence farming. While large parts of Africa are relatively sparsely populated compared to the rest of the world, and climatic conditions provides potentially high growth levels, many countries like BRIC members are looking at Africa for foreign investments in agriculture. Further, mainly due to the generally low productivity of agriculture in Africa (for all sorts of reasons) and its high population

growth, most African countries are currently net importers of food. Therefore, developing the African agricultural and economic potential is likely to remain a continuous challenge in the future.

Who will produce and eat tomorrow's food is a complex and uncertain issue. As a result, having a broad sense of thoughts about the future of agriculture is of utmost importance. Thinking only from a Dutch or European perspective poses limitations, especially as resource markets, including food, are becoming increasingly global.

For the above mentioned reasons, we performed a research to find out how different countries, in the Chinese, English, and Portuguese language domains, as well as in Africa, are thinking about the future of agriculture. For this purpose, we used the HCSS MetaFore protocol as a methodology for the systemic coding of relevant government and think tank foresight studies about this topic. This study was performed as part of the project *Future Contours of Agriculture and Food*. It seeks to better inform decision makers from government and industry in preparing for the challenges of this future environment. It has a modular setup: the results presented here can be built upon in order to gain a better insight in the future nature of agriculture and food. More generally, they could provide supporting material to develop agricultural policies that would help both producers and consumers benefit from the fruits of sustainable food production.

Agri and food chains in the global economy are changing. Emerging economies such as China and Brazil are strengthening their global dominance. In the next decades, the rise in global demand for agricultural products is likely to stem from emerging economies like these. Therefore, learning about their strategic visions for the future and their understanding of drivers of change will help to strengthen our strategic foresight in the Netherlands and Europe in preparing policy and research agendas. This reflects the priorities of knowledge and anticipation, identified in many strategic documents.

The Netherlands will have the presidency of the council of European countries in 2016. The future of agriculture and horticulture is one of the topics on the policy agenda of the Ministry of Economic Affairs in preparation of the Dutch presidency. A foresight study could provide precious insights and a wider perspective on global views on the future of agriculture, and address relevant topics to be addressed by policy and research management groups. This should help to gain momentum in the conceptual thinking of agri and food chains, as well as knowledge production and valorization.

From the perspective of a global agri and food economy, it is important to be aware of visions of the future from emerging economies, such as Brazil, China and India, which are likely to be decisive factors and players in the future of agriculture. Africa is also a continent of importance to the global food system, not only for its challenges, but also for its potential and opportunities. It is incidentally becoming a strategic continent for the BRICs too. Understanding these views about future trends and drivers of change may shed light on important global developments that may affect the agri and food system. For instance, results could inform about China's visions on how to sustain Chinese food consumption in 2050.

This type of a foresight study would add to the rich tradition of foresight studies in support of policy agendas for agri and food research. The Standing Committee of Agricultural Research (SCAR) of DG Research of the European Union has completed three foresight exercises over the years and has recently initiated the fourth edition. These build on the latest state-of-the-art research on trends, drivers of change, and criticalities in the agri and food system to generate visions in terms of scenarios and building blocks for the future.

Most foresight studies from leading institutions have a wide scope and look globally in their horizon scanning and searching for weak signals. Despite their often global influence, they tend to address mainly studies from the 'West', and reports by international (governmental and non-governmental) organizations. Foresights and vision documents from emerging economies are generally not disclosed. This information is additional to policy documents by governments, which outline the national priorities of countries. Further, they are complementary to the analyses provided by statistical outlooks from the Organization for Economic Co-operation and Development (OECD) and the Food and Agriculture Organization (FAO), which provide trend indicators and projections about global agriculture. As such, the broader vision on the future of agriculture displayed by foresight studies from emerging agricultural economies should be able to yield fresh insights to feed into the discussion by policy and research management groups.

The findings presented in this report should not be interpreted as a prediction of the future or comprehensive. We tried to capture the essence of a broad foresight discourse using our methodology. However, the inherent complexity and uncertainty of the future in all its dimensions, and that of geographical environments should not be ignored.

The structure of the report is as follows. The second chapter offers an in-depth description of the study's background and the methodology. The third and fourth chapters provide our assessments of prevailing views on the future nature of agriculture and food in the Chinese, English (for India), and Brazilian language domains, and in Africa as a geographical zone. These assessments are based on a selection and analysis of foresight studies, processed through a text mining tool (results in the third chapter), and manual coding (results in the fourth chapter). In the fifth chapter, we provide the main conclusions of this report.

2 METHODOLOGY, CHOICES AND PROCESS

2 METHODOLOGY, CHOICES AND PROCESS

In this study, we make use of the innovative 'Metaforesight' methodology for agriculture and food. The goal of this approach is to enhance awareness of emerging issues and drivers of change from other parts of the world. It intends to reveal visions of the future from emerging economies and languages that are generally not addressed in Western foresight studies.

Metaforesight adds value to decision making and planning processes, as it is an systematic way of gaining a better understanding of the bandwidth of views about the future security environment – views that do not only include those from Western countries. The idea is to support the production of more robust, adaptive and flexible strategies for the long term.

This method was previously used in some recent HCSS work for the Dutch government's 'Strategic Monitor', which tries to anticipate the future in the area of foreign, security, and defense policy. This way, threats and opportunities in the future security environment can be better defined and assessed, supporting the transformation of planning methodologies.[1]

2.1 Background: Metaforesight for evidence-based policy making

HCSS has been looking for ways to present decision-makers with a balanced and informative overview of different insights about the future. We try not to take sides in the many substantive, ideological, methodological, and political debates that permeate discussions about the future and the 'futures' field. We are constantly and painfully reminded of the various well-known pathologies that we humans encounter when we try to wrap our minds around the future. Thinking patterns such as recentism, presentism, confirmation bias and narrative fallacies tend to limit our capacities to think broadly about alternative futures.

The policymaking community puts ever more emphasis on basing policy on rigorously collected and curated objective evidence (i.e., 'evidence-based policy'). But what is the equivalent for the future of what 'evidence' is for the past and present? Our method reflects what we call 'foresight 3.0': an attempt to distill more insights about the entire future space by systematically collecting, parsing, visualizing, and analyzing a large database with elements of the future (e.g., *futuribles*[2]) as they are perceived across the globe. This global 'Futurebase' allows policy analysts and policymakers to gauge the bandwidth of views on these *futuribles* across different constituencies (and different languages and cultures). The hope is that such an approach will allow us to transcend some of the widely acknowledged bias problems with many current approaches to foresight.

One of our approaches at HCSS, is pursuing to move the current debate about foresight for strategic planning in more of a systematic direction: the HCSS *MetaFore* approach. The essence of the protocol defined is that we try to collect and process a much larger corpus of foresight studies in a particular field than has hitherto been possible. We code this literature with both manual, for the smaller sets, and semi-automated, for the larger sets, coding tools. The results are then visualized in different ways and analyzed. We have called this approach 'Meta-fore': 'moving beyond' (Greek: *meta-ferein*).

2.2 Potential and workings of a multilingual metaforesight protocol

Working with a global team, a substantive collection of foresight studies in different 'language domains' or geographical zones can be harvested, coded, visualized and analyzed. The coding process combines the qualities of manual, human coding and automated coding. At the heart of the protocol is the constant reflection and cross checking across the languages (and sources) of the sense making that lies beneath the coding. The coding itself is not intended to reduce, but to synthesize the data. Further, the original source documents can always be manually accessed to refine the coding process and build insights as a result of the analysis.

The starting point for the protocol of this methodology has been to overcome the subjectivity and normative aspects of foresight studies. By analyzing a pool of foresight studies globally, the metaforesight approach tries to capture a broader bandwidth of views than is possible when one works within one, implicitly biased viewpoint. The coding process of weighting the different types of content that are mentioned in the reports helps to reveal the dominant themes in the foresight studies. It shows the

way certain drivers of change are discussed, which stakeholders are involved and many other aspects of meaning that are important in these foresight studies. It also reveals the blind spots of themes that are discussed more in-depth in some language zones, but more or less ignored in other parts of the world. In this way, the meta-foresight study gives a multi-perspective approach. The insights can be truly refreshing and may trigger deeper drill-downs into the riches of these multiple futures.

The importance of this to policy makers cannot be underestimated. We submit that such foresight approaches represent the 'future's' equivalent of the unbiased 'evidence' that is increasingly becoming the basis of policymaking. Any prudent strategic decision-maker would be well-advised to carefully stress-test the robustness of his strategic decisions against as broad a segment of the entire future space as she can absorb. Multilingual approaches will increasingly play key role in this.

Despite these unique advantages with respect to strategic policy making, multilingual meta-analysis also has some inherent drawbacks. Policy-makers often miss the more linear 'narrative' quality of scenarios that they can fully absorb. What we have, therefore, done in other work,[3] is to use the distribution of views on various parts of the future (*'futuribles'*), and the factors and clusters that tend to emerge from it to construct scenario ensembles that can then be 'narrated' in a more conventional way.[4]

It should be noted that this methodology is recent and still in development. Currently, manual coding is a large component of the data analysis. However, this has limitations in time constrains, human error, subjectivity, and cognitive fallacies that we humans fall prey to. This could be a temporary issue, as we are just entering the age of big data analysis, which holds a strong promise for the analysis of large pools of documents. New tools from this field are being introduced to our protocol, which not only open up possibilities for enhanced automated coding, this also helps to develop techniques for displaying insights from a broad diversity of sources in a way that supports strategic policy making.[5]

Toolbox

Metaforesight synthesizes the bandwidth of views on particular aspects of the future through a meta-analysis of large sets of foresight studies. This method is supported by a rich, diverse toolbox facilitating the processing and an unbiased analysis of large quantities of studies and unstructured data. This toolbox includes:

- A large database of foresights, regularly updated
- The use of qualitative and/or quantitative methods, including:
  – Manual coding software (e.g., Nvivo, Dedoose)
  – Text mining software (e.g., Leximancer)
  – Online bibliography, Zotero,[6] to store downloaded files and generate visuals through an extension called Papermachines/Mallet[7]
- The visualization of the results, using
  – Geomapping
  – Heat maps
  – Histograms
  – Word clouds
  – Streamgraphs
  – Online consultations with experts and leading innovators from the business world, government, scientific community.

Protocol

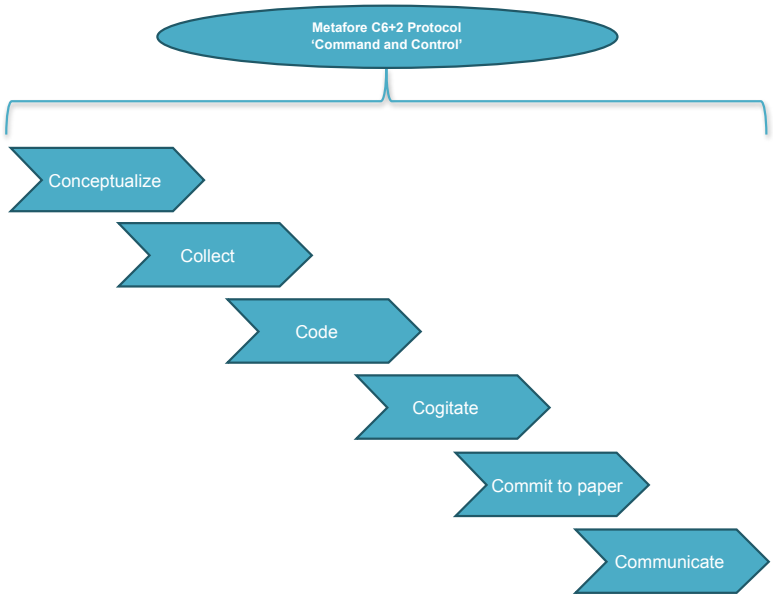

FIGURE 1. THE BROADER METAFORE PROTOCOL APPLIED TO THIS METAFORESIGHT STUDY

The protocol used in this study (Figure 1) is a decentralized structure to create real time communication and collaboration environments. The protocol can be shortly described with the next 6 characteristics:

1 Conceptualize: the HCSS team determines the boundaries of the study (definition and delineation of what to include and not to include in the study)
2 Collect: the entire team (both at HCSS and in different parts of the world) collects as broad a set of serious foresights studies on the topic as possible;
3 Code: the team rigorously codes all relevant pieces of information on the topic in every study;
4 Cogitate: the team analyzes the data culled from the coding effort;
5 Commit to paper: the team writes up the main findings of the study, in as visual a way as possible; and finally
6 Communicate: the team tries to inject these findings in the broader policy process.

2.3 The study: Parameters, design, process

Research questions

The research questions guiding the study are listed below:

- What is the perspective of the future of agriculture, food systems, forestry, and fisheries in Brazilian, Chinese, and Indian foresight studies, and for Africa?
- What is the bandwidth of views among experts on every single issue or general distribution of findings?
- Are there any robust findings, where there seems to be consensus among experts?
- Can we find any weak findings that may run against the conventional wisdom, but still seem worthwhile: interesting outliers, or plausible, internally consistent foresight views that seem to represent a minority view?
- In what sense are the Brazilian, Chinese, Indian, and African views different from Dutch or European visions of the future?
- Which blind spots from the Dutch or European perspective can be revealed from these differences?

Nature of the project and research mode

The project had an important methodological component, but also had to deliver useful substantive results on the basis of these tools and methods. It was agreed that the mode of research would be semi-automated and multilingual.

The final interpretation of these results still required human knowledge and creativity. The results of the semi-automated analysis were, therefore, automatically visualized in a number of different ways and accompanied by an interpretation of these visuals by human analysts from HCSS or ecosystem partners.

The countries or geographical zones that were selected to be analyzed included:

- Brazil
- China
- India
- Africa, specifically South Africa

In all cases, the foresight studies were downloaded in all available languages and text-mined.

Originally, we intended to look at Nigeria – a country-specific request by the Ministry of Economic Affairs – which fits our methodology, as we also look for Brazil, China, and India. However, the results were disappointing, in spite of a search via Google and despite targeting a list of particular institutions. We tried to extend the search to other African countries. Most of them are concerned with agriculture and food futures, so we refined the selection based on several indicators, including the level of their dependence to food import. We also decided to include South Africa given the size of its economy, which is significant compared to other Sub-Saharan African countries, and its economic involvement in other Sub-Saharan African countries.

Unfortunately, the results were not very solid, with the exception of South Africa. Further, for Africa, the functioning of Google is counterproductive for this task, as it lists websites by the traffic they have or generate – and there is much less traffic in Africa. In addition, we noted that international organizations like the World Bank and the UN are listed at the top of the query results in Google, while a unknown African organization is probably generating less traffic and will thus be far lower on the list. Finally, it is seems likely that much of the type of foresight research we are looking for is conducted by 'Westerners' anyway, potentially linked with a number (a few) of local civil servants or decision makers.

In our opinion, based on this assessment, many of the 'real developing' nations in Africa will likely not be home to domestic organization looking into these issues, for several reasons. First, most educated people that could do this kind of work are working for international organizations (i.e., knowledge drain). Second, it is not necessary for African countries to conduct the research themselves, as international organizations are already doing so, often in collaboration with local partners. Such work is thus more or less outsourced from the beginning. For these reasons, HCSS suggested a dual track approach for the 'African' selection of foresights:

- We include the strongest foresights found so far with our country-specific search (particularly South African studies)
- We include the strongest foresights published by international bodies on the future contours of Agriculture and Food in Africa (generally for the continent or a region, e.g., southern, eastern, or western, and including analyses for countries more specifically), especially if they were developed together with local partners.

2.4 Research design and process

We collected foresight studies from each of the different countries, which involves in most cases different 'language domains' or geographical zones (and translate a perspective that goes beyond that of 'the West'). This collection was based on a number of selection criteria.

Diversity

Foresight studies would have to be from renown, influential publishers: research institutes or think tanks, non-profit and non-governmental organizations, academics, 'out-of-the-box' (i.e., less conventional pieces of research) or from main national sources like governments (which may disclose official policy foresight documents). Essays and op-eds, or newspaper articles could be selected as well, as long as they were foresight-oriented.

For studies including a 'Western perspective', we usually include resources published by institutions like the UN, the WTO, and the EU. Further, main global institutes, like the FAO, OECD, and World Bank were also excluded from the study, because they reflect this Western perspective.

If relevant, it was possible for our analysts to include 'voices' of less dominant institutes, as well as documents from industry stakeholders to provide additional references to the delineation of drivers for change. For the Western language this usually includes publications from companies like McKinsey, PWC, and Shell.

The protocol we followed considered the following elements:

- Scale: from global and regional to national.
- Focus: the broader theme or specific sub theme, for example, agriculture in general or food security in particular.
- Time span: The time-period selected was from 2011 to 2014, allowing a selection of relatively recent – thus relevant – studies. However, Brazil and China include studies from 2010, due to the fact that these were too rich in insights to be ignored.

- Language and authors from the country studied: Portuguese from Brazil, Mandarin from China. Only keep the studies that may be written in English but that are at least written by, for example, Chinese authors or Chinese institutes (we are interested in the perspective of China as a language, as a country).
- Quantity: 'A sufficient amount' in the proposal. If we manually code studies, we should limit ourselves to about 30 studies per language domain (and adjust, depending on the length (for example, Chinese studies are always shorter due to language specificities).

We first conducted a quick scan on Google search of some main foresight publications and major organizations (from each country or cultural domain), likely to publish foresight research. For example, the quick scan conducted by our Indian analyst resulted in listing organizations such as the Ministry of Agriculture, including the Department of Agriculture and Cooperation, and the Department of Agricultural Research and Education; the Indian Council of Agricultural Research; the Agricultural Census of India; the Farmers' Portal; the India Brand Equity Foundation (agriculture sector); the Indian Agricultural Research Institute; and the National Academy of Agricultural Sciences.[8] This round of research was then complemented by more research based on a set of search queries which can be found in the appendix.

The HCSS team developed this strategy for collecting as wide a range as possible of publicly available, serious foresight studies on the future of agriculture for the various language domains or geographical zones. Every ecosystem-partner searched the internet and some academic full-text databases using a search algorithm that consisted of two main broad 'semantic baskets':

- The nature of agriculture and food: various words such as agriculture, food, food system.
- The future: words as foresight, forecast, scenarios, trends, drivers, in the future, and 21st century.

An example of an early search query in the English-language domain can be: '(Nature OR character OR Type) AND (Agriculture OR Food OR Agriculture system OR Food system) AND (future OR scenario OR foresight OR century)'.[9]

Coding and text mining

As the collection process was taking place, the analytical team started preparing the text mining effort by looking for words that are used in the different languages – and especially in official documents – to convey the various topics that had to be analyzed.

Once the initial set of studies was downloaded, we committed to two research tracks to be based on two types of analytical tools:

1 Manual coding
2 Semi-automated analysis

The next section describes these techniques in some more detail. Various limitations and caveats can be found in the Rizzoma online topic (access available upon request).

Manual coding

Manual coding serves to identify relevant pieces of information on the topic in every study (e.g., economy, society), to outline the parameters pre-defined and refined, informing our analysis on the different elements that emerge, and ultimately, to address the research questions. For this purpose, the team used an open-source online interface, Dedoose.

We base the coding process on a coding scheme, iteratively developed to ensure that all emerging issues are identified. In previous exercises analyzing the future contours of a particular topic or of the global security environment in general, we mapped the drivers, risks, actors, indicators, regions, domain**s**. We suggest a similar approach for this study.

- Drivers: forces that entail and bring about changes and risks;
- Risks or challenges: the uncertainties or certain matters which, if they materialize, would actually pose a threat to international security and stability;
- Actors: those who produce, trigger, or are the victims of the risks. They can include states or coalitions, intergovernmental organizations 0r IGOs like the NATO, EU, and UN, other partakers generally identified as non-state actors, for example armies, security services, but also terrorists, or, finally, a combination of the above;
- Indicators: factors through which developments and risks can be measured/assessed;
- Regions: the geographical location where the development, challenge or risk identified are likely to develop, for example China, the EU, or South America;
- Domains: the arenas in which a development, challenge or risk identified could occur. We typically include the political or policy dimension, economic dimension, and the human sphere consisting of for example the mental, moral, psychological, and physical conditions.

As we coded, we developed and refined the scheme, until it eventually included the parameters visible in Figure 2.

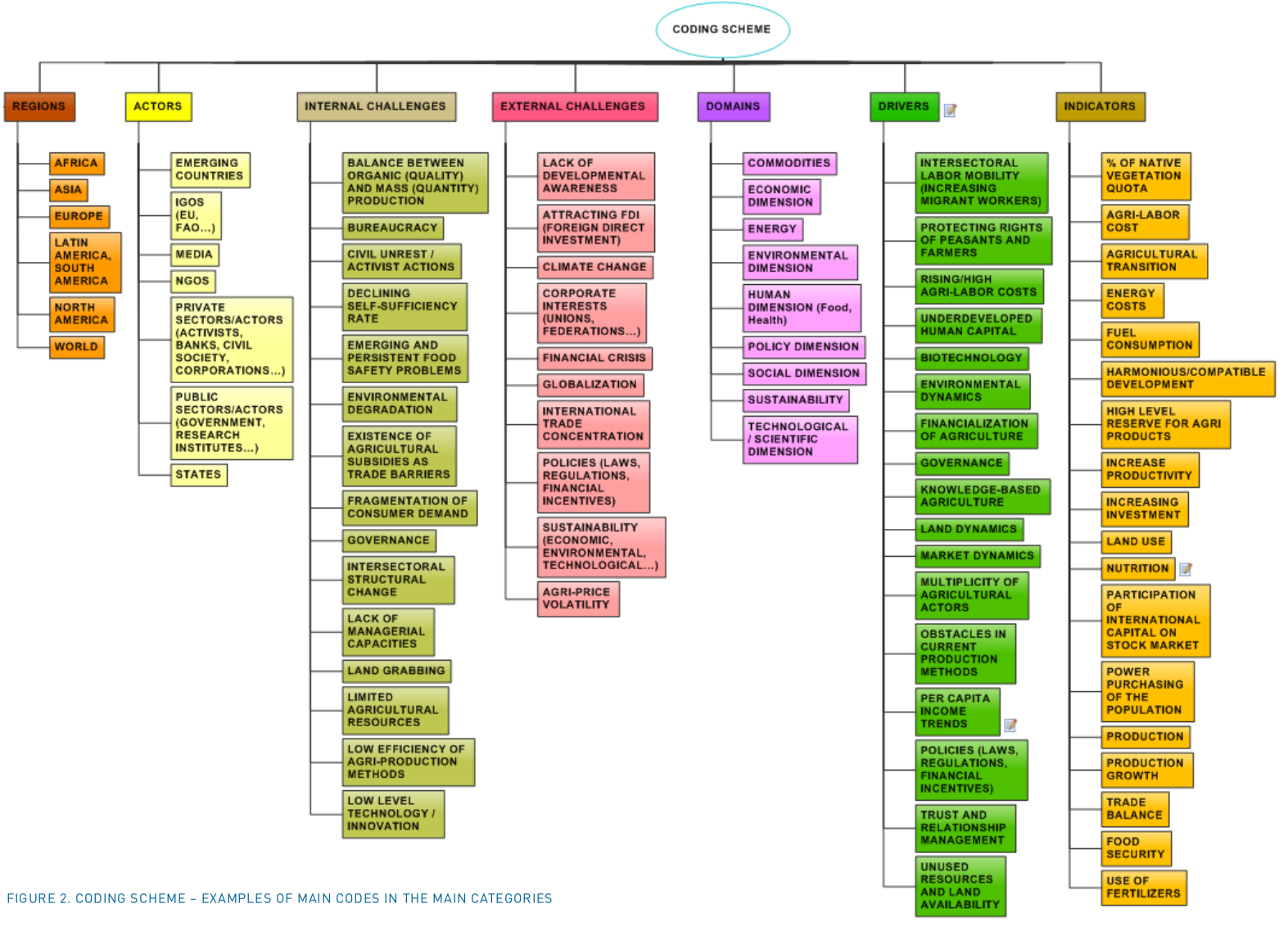

FIGURE 2. CODING SCHEME – EXAMPLES OF MAIN CODES IN THE MAIN CATEGORIES

Decisions on the level of detail and the way we coded (the logic) were made collaboratively on Rizzoma. The entire list of main codes and sub-codes within each category of parameters is available upon request. These were then processed in Dedoose, in which the results of the manual coding could be visualized (Figure 3).

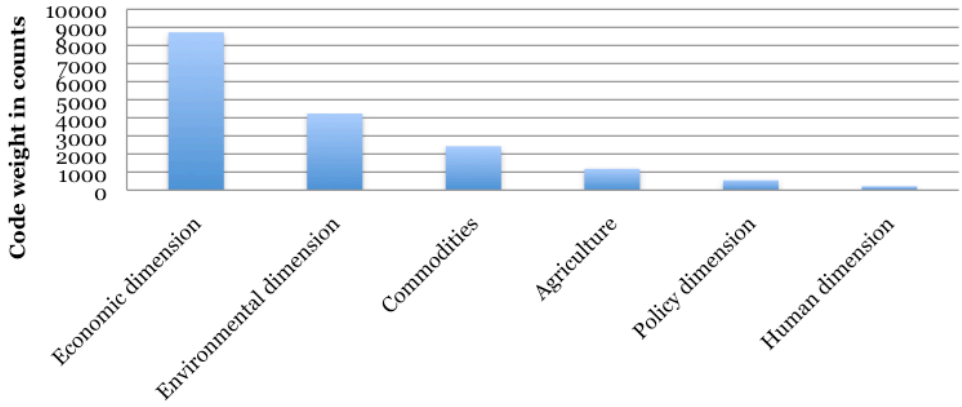

FIGURE 3. EXAMPLE OF A GRAPH BASED ON THE RESULTS OF THE MANUAL CODING (FOR THE PARAMETER DOMAINS)

Semi-automated: text mining and topic modelling

The sources (publisher and URL), the date of publication, and the raw text were stored in an online bibliographical database, Zotero. From that database, all documents were text mined to identify the key topics and their relative importance over time. These topics were subsequently visualized and these visuals served as the basis for the analysis by the entire analytical team and then the reporting.

We used a text mining tool to analyze the selected studies. Text mining tools essentially attempt to convert 'text' into meaningful 'data'. They employ a variety of computational linguistic tools to break down texts in meaningful units, to boil those units down to their very essence (e.g., by reducing various grammatical variants of a word to its basic meaning) and to then employ a variety of statistical tools to tease out significant patterns from those data.

For this project, HCSS developed a tool that allowed us to import our selection of studies into Zotero, and to then analyze those with the Mallet topic modelling tool that is available within Papermachines. Topics are terms that tend to 'travel together through the texts', which means that they co-occur more frequently within the same documents than one would expect probabilistically. The system goes through all documents and tries to 'learn', without any preconceived notions, which topics are important. Those topics are then visualized in 'streams' that are supposed to convey the waxing or waning importance of these clusters over time (Figure 4).

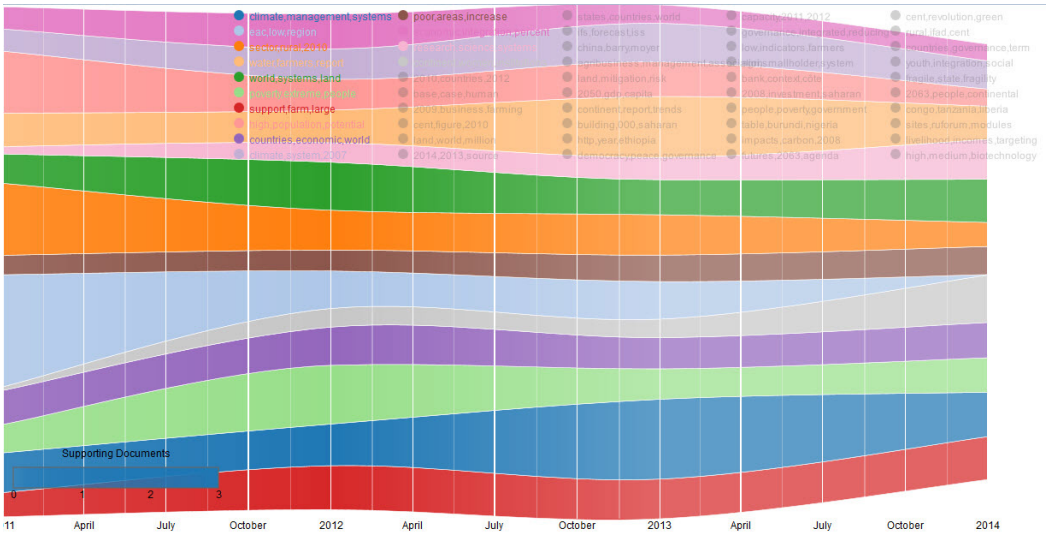

FIGURE 4. EXAMPLE OF A STREAMGRAPH FROM PAPERMACHINES

The horizontal axis shows the time in years, whereas the vertical axis represents the relative importance of the different topics within the entire set: 'wider' streams are more important, 'narrower' ones less. The legend of those color-coded 'streams' can be found on top of this streamgraph. For each stream, the main three words that dominate that topic are displayed.

More details can be generated for each stream in the form of 'word clouds' (e.g., Figure 5). Each word cloud represents the most important words that 'traveled together' through the various documents and therefore were identified as forming a topic. The word cloud is color-coded to correspond to the color of the 'stream' it explains. The size of the words reflects their relative importance within this stream: larger ones are more important than smaller ones.

FIGURE 5. EXAMPLE OF A STREAM WORD CLOUD (PORTUGUESE)

3 TEXT MINING AND TOPIC MODELLING

3 TEXT MINING AND TOPIC MODELLING

We present our preliminary analysis for the countries or geographical zones in alphabetical order, consisting of a number of key takeaways. Finally, this section will present some comparative observations across the selected countries.

3.1 Brazil

Brazil is a major global exporter striving to transform agriculture into a competitive, productive and technologically innovative sector.

Brazil's governmental action via public policies and investments is the main driver behind the country's agricultural development. Its agricultural sector is undergoing a planned transformation from a traditional agriculture model to a competitive model, driven by technology and innovation. Foresights anticipate for this 'new' model to be sustainable both in economic and environmental terms. Increasing production will be necessary to meet future market demands (internal and external). This is expected to be achieved through productivity increases and not just land use increase. As facing higher production levels is seen as a future challenge, Brazil is logistically unprepared and ill-equipped, mainly regarding transportation infrastructures and stockpiling capabilities.

Brazil's governmental action, via public policies and investments is the main driver behind the country's agricultural development. An increase in production is expected, and will have to happen in order to meet future market demands (both internally and externally). This increase is to be achieved through productivity gains and not just by increasing the land used for agriculture. Technology has, in this respect, an important role to play, and Brazil strives and seems to embrace innovation in that sector.

The inclusion of new productive systems and new methods of production requires a comprehensive structural change. Transitioning to a more efficient and productive

agricultural model encompasses change across the social tissue, the industry and the economy at large – change that can only be met with public investment. The aspired 'new' model is designed to increase production and trade, but also to be sustainable. A certain concern with regard to future impacts of the human ecological footprint and environmental aspects in general across the topics is already perceptible, though it usually is less emphasized than economic elements. Infrastructural and logistical challenges emerge as the main obstacles hindering Brazilian development, particularly in terms of transportation infrastructures and stockpiling capabilities.

3.2 China

China seeks to strengthen its agricultural sustainability through enhanced security and modernization, by intensifying domestic supporting policies and intergovernmental cooperation.

China's literature on agriculture (including issues related to sustainability (even only economic), security and modernization of this sector) has always been domestically oriented; however, it has shifted from a focus on the passive adaptation to market dynamics, to a focus that preemptively takes up substantive and innovative strategies. These involve strong supports from the government with the aim of developing biotechnologies, cultivating agricultural brands, upgrading value chains, managerial skills and infrastructure, and developing product-service system by combining eco-agriculture with tourism. However, as China can be expected to face increasing structural constraints stemming from robust economic and population growth, the existing literature indicates that both central and local governments are and will continue to ensure food security and grain self-sufficiency by progressively strengthening the country's surplus production capacities, through more efficient subsidy policies as well as investment in agricultural research in the near future. The Chinese literature has limited global focus, as its consideration on intergovernmental cooperation and openness to the international agricultural markets still bear an apparent domestic focus.

3.3 India

The selected foresight studies reflect the diversity of the vast Indian agricultural sector as well as the many challenges that lie ahead. A wide variety of cash crops and food crops find mention alongside many references to fruits and meat, milk and dairy products, horticulture and fisheries. This is an indicator of India diversifying its food basket. Primarily a response to the improving standards of living of its people, which has led to a greater demand for items such as milk, eggs and meat (considered 'luxury'

items by the poor), the diversification has also changed India's external trade equations. For example, India is now one of the biggest exporters worldwide and a major player in other poultry items as well.[10]

The diversification of Indian agriculture will also be a crucial factor determining the future of this sector. Currently, there is much pressure on traditional agricultural forms and practices as the land available for farming is shrinking and also the size of individual of farm holdings is decreasing. The Indian farmer, unlike his counterpart in Europe or America, is man of meager resources; often, he is just one bad monsoon away from suicide. So dire is the situation that every day thousands of young Indians are turning away from the agricultural sector and taking up non-farm jobs and careers. To maintain the traditional robustness of India's agricultural sector and protect the country's hard-earned good sovereignty, it is imperative to diversify, upgrade and indeed, revolutionize the sector.

In this context, it is heartening to note that the foresight studies focus on Indian agriculture as an important source of employment and entrepreneurship, even though the sector's contribution to the national GDP has been falling. Another consistent focus area is that of science and technology. There is a definite emphasis on scientific agricultural research, and the need to leverage technological advancements to increase agricultural productivity.

Finally, the role of state can be expected to grow stronger in Indian agriculture. Though this is a largely private-run sector, the government, be it at the state or union level, is an important stakeholder. For example, a lot of agro-business is conducted through state-run institutions; also, farmers make for large (if not powerful) vote banks, and politicians can be expected to protect their interests, for instance, even when negotiating at global forums.

3.4 Africa

Overall, the emphasis seems to be placed on development, environmental challenges, economic elements (growth or productivity) and concerns for the human terrain (poverty, society at large). Governance also stands out as a strong feature for the future of agriculture.

Increasing sustainability seems the main challenge and objective in the future of Africa's agriculture. The economic, social and environmental dimensions of sustainability appear to be interchangeable topics: without one of those dimensions,

food security and poverty reduction is threatened. To achieve sustainability, cooperation is assumed to be a key element – regional cooperation primarily, though international cooperation and the participation of foreign actors is far from overlooked. Structural changes and the inclusion of new technologies and methods of production are perceived as crucial for the survival of African agriculture and its ability to adapt to climate change and economic demand. Economic and financial shifts may affect prices and investments, with direct consequences on food security. Lastly, woman participation is regarded as another important factor of sustainability.

3.5 South Africa

South Africa has a socio-economic and environmental focus for policy-making and agricultural activities.

Two concerns – economic and environmental – stand out significantly from the textmined foresight selection. Agriculture in South Africa remains an activity of subsistence which provides households their main source of income in rural areas. Meanwhile, as a former host country of the 2011 UN Climate Conference and due to its vulnerability and sensitivity to the negative impacts climate change is expected to have on its agriculture, South Africa has been incorporating climate mitigation and adaptation into its policymaking on agricultural sustainability.

In South Africa, direct and indirect contributions of the agricultural sectors to GDP and employment account for 12% and 30% respectively. The agricultural sector is the second main source of national GHG emissions. This helps in explaining the fact that although the topic is examined by foresights through the socio-economic lens primarily, but there is also a strong environmental focus. Production and capacity building form an essential theme, next to governance and strategic policy making.

3.6 Cross-country comparisons

Several key topics have emerged from the text mining analysis based on the selected foresights. The variation of emphasis on these themes, key differences and similarities are highlighted in this section.

Brazilian, Chinese, and 'African' foresights focus on the economic dimension of agriculture's future. For Brazil, the national production capacity, its productivity levels (similarly to India), and agribusiness development are key topics. Soy is an important commodity that is frequently mentioned, which is not surprising as Brazil is a major exporter. Resources such as forestry (and the Amazon), and animal production are also crucial.

China places some emphasis on production – similarly to Brazil, India and South Africa – and our foresights stress the importance of agriculture to the country's economic growth, trade, standards and policies relevant to its markets and exports. India includes elements such as employment, development, exports, and entrepreneurship in farming.

Brazil's key themes include a vision for innovation and change within the public sector, and emphasize the role of the government in developing the agricultural sector. We also identify a similar perspective for China, whose foresights mention the dynamics of change and the need for domestic reforms. Political perspectives for Africa and South Africa appear more general, as we note recurring references to governance and institutions.

All countries focus on development. Brazil more specifically emphasizes the need to improve its infrastructure (similarly to South Africa), the quality of agriproducts, and we identify several references to health, sustainability and environmental concerns (deforestation, CO2 emissions). We however note the limited attention paid to societal aspects, but the interesting presence of research and technology. India also insists on science, technology and R&D. In spite of clear concerns expressed over agricultural sustainability in general, the environment and climate change (particularly for South Africa), as well as human security (society, education, people, poverty), African and South African studies appear to reflect a positive perspective as far as the future of agriculture is concerned. Opportunities and the need for adaptation are also salient elements.

China's specific features include the importance of information, consumption and concerns for growing food demand, the agricultural transition, policy and international cooperation, including with the other BRICS members. Fishery and the industry are other important topics discussed.

By emphasizing its agri sector and its various activities and commodities, India seems more concerned with the importance to pursue diversification in this field. Indian foresights mention climate change and resource challenges, as well as the key role of the government in the agricultural sector.

4 MANUAL CODING

4 MANUAL CODING

This chapter presents the findings of the manual coding. It includes an analysis of the most striking themes that have emerged from the manual coding of each set of foresights, per country or geographical zone. This analysis is informed by visuals, and also includes a number of comparative observations.

4.1 Brazil

Economic and technological drivers are at the heart of Brazil's future perspective on agriculture and food. Also significant are demographic changes and shifts in consumption patterns (e.g. more meat and animal products). Keeping up with developments on the agricultural market and the growing demand (also for exporting to countries with an equally growing demand) is set to become a particular challenge for a country whose productivity level remains low.

Brazil aims to increase production levels to avoid a growing imbalance between demand and supply, and subsequent price shocks. Studies point out that strategies for improving sustainability should take into account the fragmentation of demand (due to the demand for specialized, processed food products). With continuing trends of urbanization, worker shortage in agriculture remains a concern. Brazil is looking at technological innovations to solve various kinds of issues that pose limitations to increasing production in a sustainable way. In addition, to anticipate supply security risks for international demand, insurance schemes for crop protection should mitigate these risks.

Despite all intentions, the lack of political commitment to prepare for this future is a major issue, next to environmental sustainability. The emphasis on domains remains primarily on the economic and technological dimension, though others (political, social, environmental) are taken into consideration as well.

4.2 China

Across the foresights, drivers of future development in agri and food were typically of a policy (stricter regulations) and economic nature. They also included demographic changes (urbanization, aging of the rural population and population growth) as well as food security. Drivers of urbanization leads to reduced agricultural lands and raised costs of all relevant comprehensive production inputs, such as arable lands, labors, feeds, fertilizers as well as agricultural related infrastructure such as water conservancy and irrigation system.[11] Changed lifestyles of urban consumers trigger new demands for meat, dairy and richer food products. These drivers point to challenges, which are next to environmental degradation and climate change, shrinking arable land, resource scarcity (water), and developments on international agricultural markets – to which China will continue open.

China's approach to prepare for food security (and grain self-sufficiency) in the future is by upgrading the whole agricultural system though government incentives of subsidies, setting floor prices, strengthening regulations on output control, and in certain cases relaxation of trade barriers for specific agricultural products (such as timber). Yield levels of various staple food grains need to go up in order to avoid production gaps. China is also looking at the role of new technology to meet the challenges of the transformation of their food system triggered by large scale urbanization and improved living standards. Especially as labor shortages in agriculture are expected, China needs to rely more on technology in the future. A mix of technology and regulation is also maintained for improving environmental sustainability in agriculture and curbing pollution levels through cleaner production systems and innovative seed materials. Sustainability is thus approached from an economic point of view in terms of affecting food security. Infrastructure upgrades are not only needed for food logistics, but also to build in resilience to floods, droughts and other consequences of ecosystem degradation. Predictions about climate change and extreme weather indicate more adverse impacts for agriculture in the future. Government intervention is especially targeting for sectors facing dual challenges of resource depletion and soaring demand. Facing the declining rate of self-sufficiency leads to relaxing trade barriers, which indicates a flexible pragmatic approach. Through their growing need for import of commodities, China will be setting the prices in exporting countries.

The main regions of focus included China's own territory, as well as Africa (for collaboration in foreign investments to support China's food security) and Latin America (for providing technology to help them increase production intended for

export to China) and Europe. The US was identified as a partner. Several domains at play stand out: the agriculture and the economic dimensions, as well as the role of policy, reflected by governmental involvement and a push for international cooperation.

There is an emphasis on concerns regarding uncertainty and risk, which calls for precaution, and regarding the supply of commodities. Maintaining the balance between imports and domestic production in the face of growing demand (including for food) is particularly seen as challenging. Future actors involved will be the central government itself (interventionism), as well as corporations (e.g., through Public-Private Partnerships), or research institutes (in terms of implementation).

4.3 India

Agriculture is a way of life for the majority of farmers in India, and has influenced significantly the socio-economic development of the population. India is an emerging economic power rapidly turning from an agriculture-based economy to an industry-based economy. With a growing population and its subsequently increasing demand, arable land is being handed over to the industrialists for industrial use. Land spaces are also grabbed for building homes. Agricultural growth is shrinking – which can be a terrible prospect for a country with 1.2 billion people. Even though the consumption of animal products such as meat or milk have significant increased in the last few decades, a large share of Indians are still relying on agricultural vegetable products. Climate change and environmental degradation also affected the agricultural sector and its productivity in a significant way. Rising educational levels and aspirations among the Indian youth has reduced the supply of skilled labor in the agricultural sector. Even though India is still considered as one of the world's largest agricultural markets, it may soon have to look for resources outside its territory, and depend on agricultural imports to pacify the hunger of its humongous population.

Continued focus and innovation in agriculture appears essential to achieve self-reliance in this sector and also ensure food security. In recent decades, one of the key concerns has been the falling share of agriculture and related activities in India's GDP. In the envisaged scenarios, innovation in agricultural sector is a must. Genetically modified crops are emerging as a solution, though facing multiple socio-political constraints. Genetic research however started picking up steam in the Indian agricultural sector. Poor regulations on land grabbing have been a bane to Indian agricultural sector. Proper government policies on land issues can streamline the fertile land to step up productivity. Proper water management techniques are required to counter the effects of climate change. Irrigation system overhaul is another area

that can be beneficial to the agro-economy in the long run. River interlinking techniques can help farmers to counter poor irrigation system.

Innovations in agricultural policies or program are required at the national level, as well as at the regional level for enhancing the agricultural production and productivity on the one hand and overcoming the pitiable plight of the farmers on the other. Innovations in agriculture would need to focus on the vast untapped growth potential in agriculture, including strengthening of rural infrastructure, the promotion of agri-business and subsidiary farm enterprises and the creation of more employment to avoid migration from rural areas to urban areas. Climate change and rising temperatures are inevitable trends in India, coming with huge impacts. We need to focus on the development of drought-resistant, less water intensive and short-duration crops in drought prone distinct of the country. India could particularly adopt many of the cost-effective innovative irrigation techniques developed by Israel.

Presently, Indian fertilizer industry is growing, but fertilizer efficiency is stagnated to 40 to 55%. The use of nano technologies can increase the productivity to 70-80%. Investments in nano-technology research will serve the Indian agricultural sector in the long run. Nano-technologies such as nano-sensors and nano-based smart delivery systems could help ensure natural resources such as water, nutrients and chemicals are used efficiently in agriculture. Nano-barcodes and nano-processing could also help monitor the quality of agricultural products.

4.4 Africa and South Africa

'African' foresights broadly emphasize governance and climate change as major drivers and challenges to the future of agriculture. Other drivers include innovation, demographic changes such as population growth and urbanization, and economic drivers such as investments from the private sector. Human capital development, with a special emphasis on women's education, is seen as a strong asset to strengthen the economy and progression in agriculture.

One of the major challenges is productivity growth to keep up food production with the demands of the growing and more urbanized population. Climate change is challenging agricultural productivity even more so. Scarcity of resources such as fertilizers and optimal seed materials also put constrains to the ambitions of productivity growth. Solving issues that limit productivity growth are a powerful means to ban out food security problems.

Infrastructure upgrade and good management are other major forces identified. As far as challenges go, resources, globalization, uncertainty and corruption are important elements to watch. Future actors involved will be both governments and private sector parties mainly. Foresights also mention the role of some BRIC members, the civil society and activists. Countries that are active as foreign investors in Africa (to secure their own food supply) are considered important engines for Africa's economy. The economy, the human terrain and policy are the domains in which the future of agriculture will likely be at play.

4.5 Cross-country comparisons

Several areas of focus have emerged from the selected foresights, for each category of parameter investigated. The variation of emphasis on these themes, key differences and similarities are highlighted in this section.

The 'Region' parameter did not reveal a broad diversity and richness of results. If Brazil, China, India, Africa and South Africa stand out, it is due to the fact that the studies selected focus on each of these respective geographical zones. Asia and Africa emerge as the main strategic regions. North America and Europe are mentioned, though rarely.

Drivers

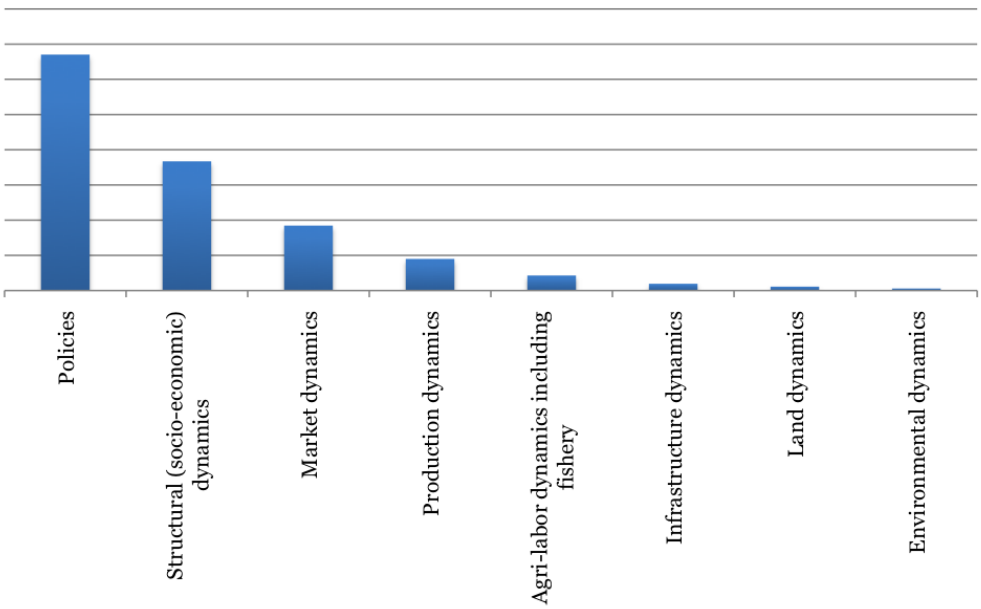

FIGURE 6. SOME OF THE MAIN DRIVERS

Looking at the overall picture provided by our coding data, the main drivers are clearly political (as policies rank first, particularly in Brazil, China, Africa) and include socio–economic dynamics. Market and production dynamics are two major economic factors broadly mentioned across countries. Agri–labor, infrastructure and land dynamics closely follow. Environmental dynamics are much less emphasized, though still emerging among the main drivers overall. It is worth mentioning other key drivers, particularly economic growth GDP and income growth, new technologies and innovation (especially for Brazil and India), strengthened agricultural regulations and agricultural supporting policies (particularly mentioned across the Chinese foresights).

Going more in-depth, Brazilian foresights place the emphasis on socio-economic dynamics, including consumption habits, the quality of foods and the adjustment to diets – to name a few remarkable examples. Market dynamics are also set to drive the future of agriculture, according to Brazil's views. They would be reflected through an increasing demand for agriproducts, demand fragmentation, the complexification of the demand, and in that more investments will be required. Technology and innovation, along with demographics (urbanization, aging) are also great forces expected to affect agriculture in the future.

China and Africa can also prepare to face the consequences of demographic changes, including urbanization (like Brazil) but also population growth. Food security and grain self-sufficiency are particular issues identified across Chinese foresights specifically, next to a multitude of economic drivers and policy trends such as stricter regulations or supporting governmental initiatives.

Infrastructure improvement is specific to China's results, while Brazil insists on changes in food consumption patterns. Africa's concerns for the role of governance are particularly perceptible, while India interestingly emphasizes the aspirations of its youth and competition among a growing multiplicity of actors in the agricultural sector.

Risks and challenges

The overall challenges reflected by our coding results are broadly of environmental, economic and political nature. Most countries wary of environmental degradation, are concerned with the challenge of achieving sustainability in the agricultural domain. All recognize the increasing risks and uncertainties in terms of agricultural production. The need to implement policies, including laws, regulations or financial incentives is also clearly underlined. Another major challenge to overcome includes the inefficiency or obsolescence of infrastructure. To complement this overview of main challenges, it

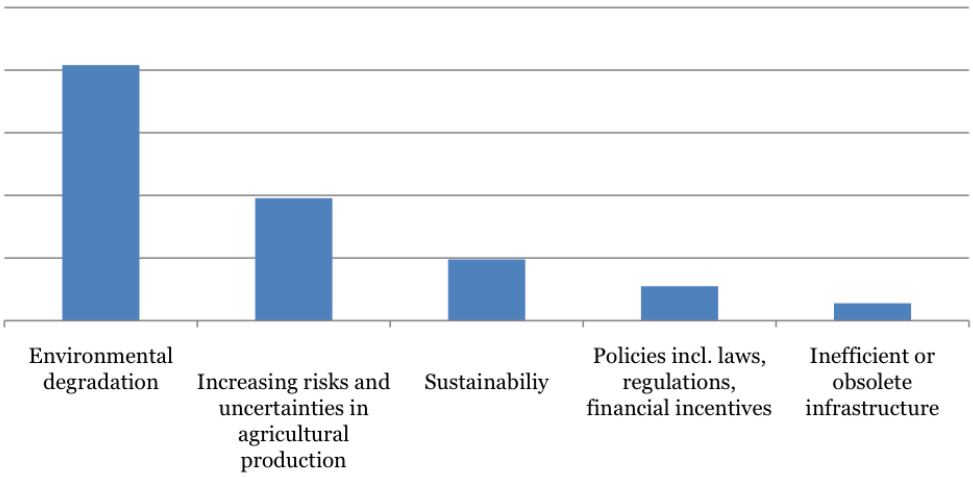

FIGURE 7. SOME OF THE MAIN CHALLENGES

is worth mentioning a number of other issues that may seem 'secondary' given their lower weight in coding, yet they are just as interesting. To name a few examples, agri–market failure is clearly a challenge in the Brazilian perspective; China focuses on economic challenges as well, such as the increasing demand for food and products and the need to deepen its openness to international markets, but also environmental ones – with the impacts of climate change and shrinking arable land, water shortages, extreme weather conditions. The low efficiency of agricultural production techniques is also emphasized by Chinese foresights; similarly, Brazilian studies point to the low level of technology and innovation.

Brazil's main concern is about maintaining its agribusiness sustainability in the future, and on several levels – including technological and economic. Brazil acknowledges the crucial need to improve its infrastructure and catching up in terms of technology and innovation, at the risk of not being able to cope with growing demands for agri-products. Low technological penetration and low productivity may become major issues for Brazil. Similar concerns are manifest in India as well: foresights focus on ways to improve productivity and infrastructure, the lack of scientific knowledge, and the need for better irrigation systems.

In addition, Brazil underlines the negative impact a lack of political commitment would have on the future of agriculture, while China insists on the challenge of opening up to international agricultural markets. Agri-market failure emerges from both Chinese and Indian foresights.

The coding results for Brazil show concerns for environmental degradation, but far less than what the Chinese data reveals: environmental degradation and climate change, shrinking arable land, resource scarcity (water) are as many key drivers identified. India also insists on these environmental challenges. As observed across African foresights, poverty is considered as a major risk.

Actors

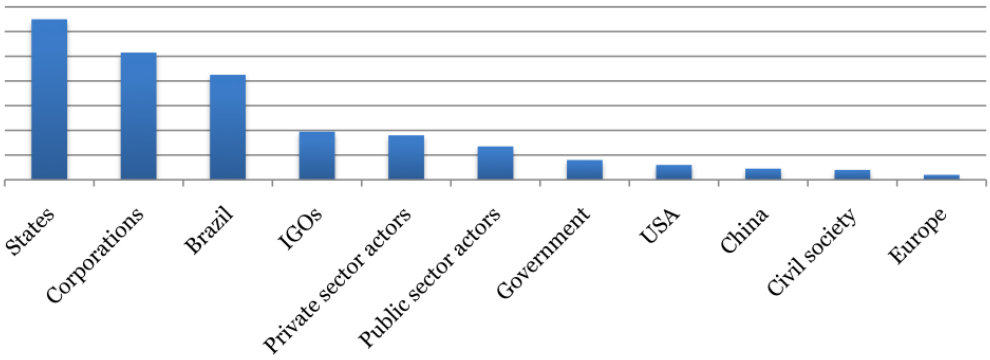

FIGURE 8. SOME OF THE MAIN ACTORS

States and governments clearly are in the driver's seat when it comes to the future of agriculture and food. However, their influence or role is challenged or seconded by corporations, and (though to a lesser extent) by International Governmental Organizations. One can only be surprised by the limited role of Western countries and even more, by the fact that the civil society barely stands out.

Brazil and China decidedly adopt a domestic, inward focus, as major players (and territories) in the future of agriculture. The EU does not emerge as an actor acknowledged by Brazilian views for its importance, contrary to the US, China or India. The US is also a partner to China, whose foresights mention Brazil, Africa and Europe as strategic actors. 'African' foresights include members of the BRICs like Brazil, China and India.

Brazil emphasizes the role of private sector actors (e.g., corporations) more than that of the public sector, while China, India and Africa insist on the combined involvement of the central government and private sector actors. India particularly mentions PPPs, while we find actors such as the civil society and activists across 'African' foresights.

Indicators

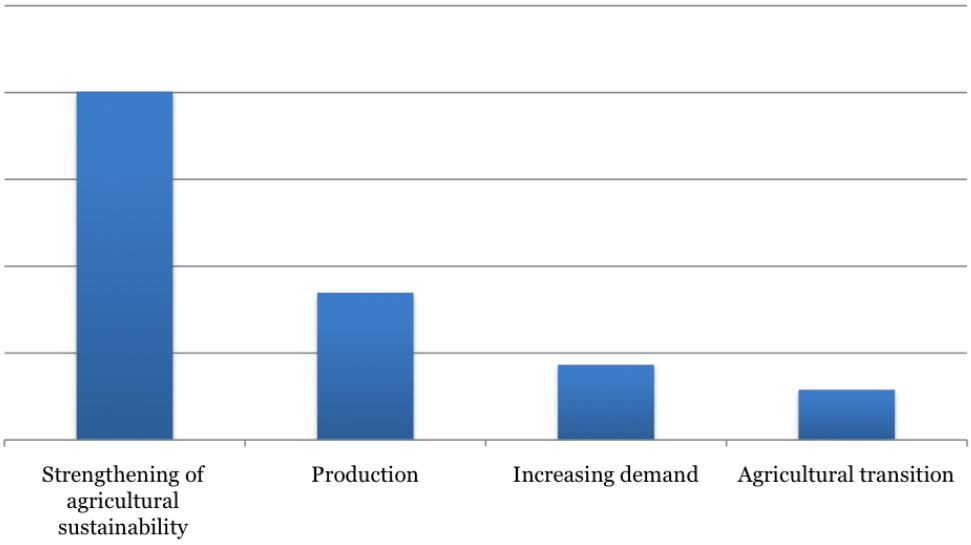

FIGURE 9. SOME OF THE MAIN INDICATORS

Strengthening agricultural sustainability is a major direction likely to characterize the future of agriculture and food. This is particularly underlined across the Chinese studies, though much less in the African perspectives. Production is broadly mentioned across countries, as well as increasing demand and the 'agricultural transition'.

Other key indicators include monitoring for an harmonious or compatible development (Brazil, China), increasing food consumption, agricultural modernization (including Africa), increasing output and the balance between imports and domestic production (China), productivity (Brazil, India, Africa), land use (Brazil). Interestingly, China mentions the professionalization of rural socialized service system and the establishment of a precautionary system for unexpected disasters. India particularly focuses on technology penetration.

Domains

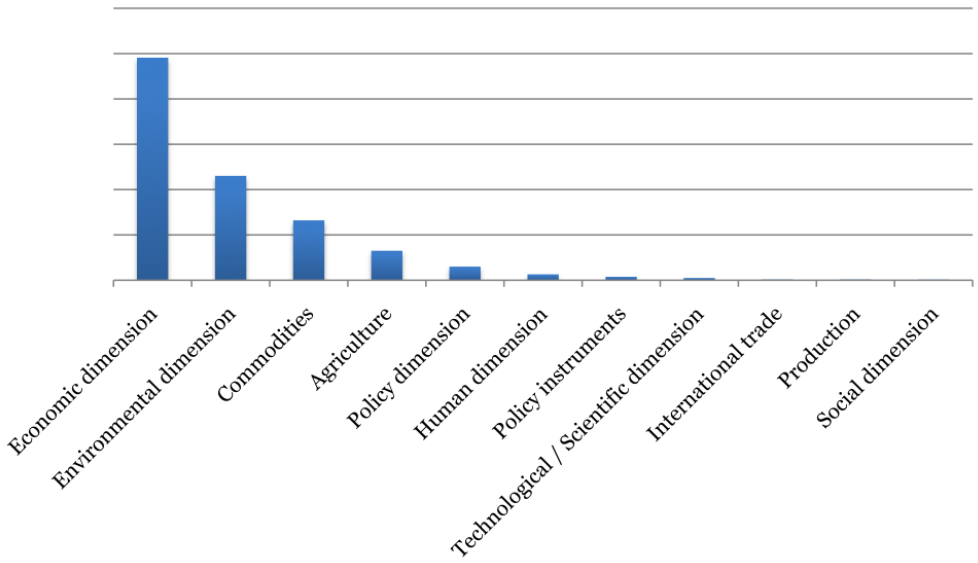

FIGURE 10. SOME OF THE MAIN DOMAINS

Typically, most countries emphasize mostly the economic dimension (particularly international trade and production, as well as exports), followed by the environmental dimension. More empirically, commodities and the agricultural field are other key domains. Policy dimension and instruments, and well as the human terrain, also cover for a significant share of our coding results. The technological, scientific dimension and the 'social' domain should also be mentioned here – they are particularly emphasized by China.

Brazilian foresights focus their attention on predominantly economic developments (export), then the technological domain (biotechnologies, energy). India also insists on the technological and scientific domains, while Africa's focus is on both economic and human terrains. China's dominant dimensions are economic (import, production) and about the supply of commodities, while a policy dimension (including governmental intervention but also international cooperation), stands out quite strongly as well.

5 CONCLUSIONS

5 CONCLUSIONS

This study aimed at providing insights and a wider perspective on global views on the future of agriculture. Based on our review of foresights studies published about this topic in Brazil, China, India, and regarding the African continent, and using text mining tools and coding, we identified a number of relevant topics. We hope for these findings to support research and policy making in the Netherlands and Europe.

Perhaps unsurprisingly, all perspectives recognize the increasing *risks and uncertainties* in terms of agricultural production. Most countries are concerned with the challenge of *achieving and strengthening sustainability* in the agricultural domain – sustainability, in all its different dimensions: economic (e.g., market failure, risk of insufficient infrastructure or techniques, hindering production), political (such as insured by the continuity of policies and regulations), and environmental (e.g., the impact of increasingly frequent weather hazards on crops).

All views decidedly focus on the *economic dimension* of agriculture's future. Many of the selected players are mainly concerned with the challenge of increasing production to be able to face a growing global and national demand for commodities. Concerns are raised over the infrastructure that needs to be upgraded and the sustainability of production models. Brazil and India particularly mention the importance of increasing productivity levels. Maintaining positions and influence in global trade is one of the underlying objectives. Developing economies are aware that the agricultural sector is a major source of economic growth and employment.

In reaching these objectives, governments seem to have a key role, in order to reform, implement *policies* supporting the sector and protecting stakeholders (such as farmers). Yet private sector actors are set to have a growing influence – and would be indispensable in facing future challenges through investments and collaboration with public sector actors.

Human security is another key theme, drawing from *environmental degradation,* resource limitations and the disastrous impact of climate change on these exposed 'southern' regions, to food security in terms of health, quality, and supply (how to feed growing populations?). We should be prepared to face the consequences of demographic changes, including urbanization and population growth, and shifts in consumption patterns.

Overall, there is a consensus on the efficiency of a *combined involvement of central governments and private sector actors* in the future of agriculture. There are many discussions on *agricultural modernization and transition.* And it should be noted that good and reliable global *governance* and international cooperation are emphasized as supporting elements of the road towards agricultural sustainability, as well as the need to focus on *knowledge generation* through human capital development, research, technology, innovation and scientific progress.

5.1 Implications for strategic long term visions for Dutch agricultural policies

This report has provided an extensive overview of drivers for the future of agriculture of some of the most influential global agricultural economies. From this broad analysis of these countries strategic outlook for the future, we highlight in this section some of the issues mentioned that seem particularly relevant for Dutch agricultural policies. We first briefly summarize the vision for the Dutch economy by the Ministry of Economic affairs, before identifying a number of economic opportunities for the Netherlands.

Vision for the Dutch economy by the Ministry of Economic affairs

The Ministry of Economic Affairs has recently presented an analysis of challenges for the future of the Dutch economy. The report also describes the contours of a dynamic and sustainable Delta, as a vision for the Dutch economy. Key in this vision is the central position of societal challenges in innovation policy. Knowledge development is the way to generate products and services that can provide solutions for global challenges. One example is saline resistant seeds, to anticipate a growing demand caused by soil salinity (as a consequence of unsustainable irrigation). Another main characteristic of this economy is the emphasis on giving room to new ideas and new business models. Providing new opportunities with innovation policies, stimulating people with all sorts of skills, and giving them room for experimentation and incremental learning. Last, the intention to build new connections, new collaborations over production chains and across sectors is emphasized. This way, entrepreneurs can tackle challenges of several nexuses, such as water – food – energy and food – nutrition – health. Innovative solutions to global challenges are thus more likely to emerge.

Dutch opportunities anticipating challenges for the future of Brazil, China, India and Africa

Given this vision for the future of the Dutch economy, we identify several challenges for the future, recognized by the emerging economies addressed in our meta-foresight, and to which the Netherlands can provide a solution or regarding which it can take on the role of a helpful partner.

Brazil

Brazil's main challenge is to maintain growth in agricultural productivity for an increasingly urbanized population with a large appetite for animal products, and for export to nations which undergo similar increases in demand. Avoiding ecosystem degradation is crucial here, but also to establish innovative agricultural production techniques and logistic structures given a decline in agricultural workforce.

While China is offering ever more technological support for innovative solutions (to meet their self interest of increasing production and export figures), there is clearly room for various kinds of collaboration in high tech, climate-smart agricultural production and logistic systems. In addition, Dutch industries can support a market for meat alternatives, which could be a solution for curbing the meat consumption levels and reducing the stress of the market's demand for meat.

China

The foresight reports indicate that China is preparing nothing less than an overhaul of the food production system in order to meet future demands in face of climate change and environmental degradation. The country needs now (and in the future) a transition from an agricultural system of smallholders to a production system tailored to feed a largely urban population with a raised living standard and food safety demands. Increasing domestic production as well as securing supply chain from imports and foreign investments are important. The risks of climate change and pollution are serious threats to achieve food security without price spikes in the future. China has a government-centered approach. For collaboration with China it is crucial to understand the local customs of doing business in a state-led country. China's investments in Latin America and Africa to help secure their resource demand indicates the growing competition between Chinese companies and the Dutch in many agricultural sectors, including research and innovation.

India

Also India is looking in various ways to improve agricultural productivity. India is particularly interested in a high-tech approach to agriculture. Biotech applications and

improved fertilizers are some examples of India's needs. The country has an enormous workforce, many poor rural smallholders, but also large universities that focus on high-tech solutions for agriculture. Collaboration on knowledge-intensive agricultural products helps to build ties between the Netherlands and India, to strengthen our foothold in a country with one of the largest populations in need of improving food security. Much more than China or Brazil, India favors public-private collaboration instead of government-led policies. This could be an advantage for mixed consortia focusing on India.

Africa and South-Africa

Population growth and urbanization, vulnerability to climate change and environmental pressures, and governance issues summarize some of Africa's main challenges for the future of agriculture and food security. Political will is considered a hurdle in making progress with the solutions identified. Improving productivity growth in a climate smart way is crucial. Foreign investors such as China are making efforts in this respect, but their main goal is boosting Africa's exports instead of focusing on local needs. Africa stands out in their efforts to improve women's participation, recognizing their constructive role in the local community, in households and as entrepreneurs. Research and business activities that find a good match with the local needs can help to provide integral solutions for Africa's needs for food security. Strong local knowledge can be an advantage to have a better understanding of what would work out in each case. The constrains caused by bad governance and domestic issues are drawbacks for Africa's food challenges, which need to be addressed to facilitate agricultural business relationships.

5.2 Strands for further research

This report has provided a first layer of data analysis from a large dataset of foresight studies. We used two different research strands, automatic and manual coding, for bottom-up analysis. That is, we worked from the findings that emerged from the data. No additional top-down analysis was done, in which specific questions were addressed to zoom in on certain topics. Top-down analysis is a way to look closer at specific issues, to refine the picture that emerged from the most salient issues mentioned in the foresight studies. This would be a way to look closer at for instance, the future of bioeconomy in these countries and how it interacts with the future needs of the food system. Specific issues such as future visions on animal health, food production and water scarcity, or food logistics can also be addressed in depth to find out how these economies envisage the future in these domains. The database that was built for this Metaforesight study consists of hundreds of coded and parsed foresight studies in multiple languages, which can be a real goldmine for outlining how some of the most influential economies globally see the future unfold.

ENDNOTES

ENDNOTES

1 Examples of implementation in previous reports: HCSS, *STRONG in the 21st Century*. Strategic Orientation and Navigation Guidance under Deep Uncertainty, 2010, http://www.hcss.nl/reports/strong–in–the–21st–century/11/; HCSS, *Contours of Conflict in the 21st Century,* 2011, http://www.hcss.nl/reports/contours–of–conflict–in–the–21st–century/17/; HCSS, *Strategic Monitor 2012: Licht of de Toekomst, Zeven Perspectieven*, 2011; HCSS, Strategic Monitor 2013: De Toekomst in Alle Staten, 2012, http://www.hcss.nl/reports/de–toekomst–in–alle–staten/123/. See also this video: https://www.youtube.com/watch?v=rAvVLVmR6AY.

2 See Bertrand de Jouvenel, "Futuribles", 1965, http://www.rand.org/content/dam/rand/pubs/papers/2008/P3045.pdf.

3 Stephan De Spiegeleire et al., *Future Worlds. An Input into the NATO Long–Term Requirements Study,* CCSS Report for NATO Consultation, Command and Control Agency (NC3A)'s Long–Term Requirement's Study, (September 2005); Eline Chivot et al., *European Capabilities Assessment Game – Towards Scenario Ensembles,* HCSS Report for the European Defence Agency (The Hague Centre for Strategic Studies, 2013). On the same idea, see also: M. B. A. van Asselt, ed., *Foresight in Action: Developing Policy–Oriented Scenarios,* Earthscan Risk in Society Series (London ; Washington, DC: Earthscan, 2010).

4 Our own thinking about the danger of 'narratives' has been profoundly influenced by what Nassim Taleb calls the 'narrative fallacy', which we strongly recommend all people engaged in this type of work to take a very close look at. Nassim Taleb, *The Black Swan: The Impact of the Highly Improbable,* 1st ed. (New York, NY: Random House, 2007).

5 See for example HCSS, *What the Official Websites Say. Developing and Testing a New Systematic Information Collection Method,* 2014, http://www.hcss.nl/reports/what–the–official–websites–say/152/.

6 https://www.zotero.org/.

7 http://papermachines.org/.

8 Respectively: http://agricoop.nic.in/; http://dare.nic.in/; http://www.icar.org.in/; http://agcensus.nic.in/; http://farmer.gov.in/; http://www.ibef.org/industry/agriculture–india.aspx; http://www.iari.res.in/; http://naasindia.org/about.html.

9 See HCSS, *Contours of Conflict in the 21st Century,* http://www.hcss.nl/reports/contours–of–conflict–in–the–21st–century/17/.

10 *The New Indian Express,* "UPA's Pink Revolution Makes India World's Biggest Beef Exporter", February 9, 2014, http://www.newindianexpress.com/business/news/UPAs-Pink-Revolution-Makes-India-Worlds-Biggest-Beef-Exporter/2014/02/09/article2045869.ece.

11 Xu,"China's agricultural industry is going to witness its new developmental opportunity in future 10-20 years", *China Grain Website,* 2014. Research Group of Development Research Center of the State Council, "Foresight of Chinese agriculture in future ten years: gaps in some agricultural products", Sales: Agricultural finance and market, 2014.

The Hague Centre for Strategic Studies

Lange Voorhout 16
2514 EE The Hague
The Netherlands

info@hcss.nl
HCSS.NL