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Integrated agricultural intelligence – a proposed framework

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Summary

Integrated agricultural intelligence (agri-intelligence) is a specific field of intelligence dedicated to an enhanced understanding and proactive recognition of the threats and risks to national security associated with a broadly defined agriculture. It recognises the clear linkages between different fields including public health, safety and security; food safety and security, environmental security and economic security. Integrated agricultural intelligence is needed because of the rapid rate of change in society today, including but not limited to science and technology, the interconnectedness of the mandates of different sectors and the fact that agriculture is vulnerable from many perspectives. Integrated agricultural intelligence combines inputs from a diverse and broad spectrum of disciplines and organisations and promotes not only an exchange of information but an analysis of this information. This analysis provides a mechanism to proactively anticipate threats, an enhanced and heightened understanding of these threats, more informed policy development and superior operational outcomes.

Keywords

Agri-intelligence, Agriculture, Animal disposal, Animal health, Environmental health, Food safety, Food security, Integration, Intelligence, Plant health, Public health.

L'*intelligence* applicata all'agricoltura: presentazione di uno scenario

Riassunto

*L'*intelligence *associata all'agricoltura (agri-intelligence) è uno specifico campo dell'intelligenza finalizzato ad una migliore comprensione ed al riconoscimento delle minacce e dei rischi per la sicurezza nazionale associati con l'agricoltura in genere. Essa riconosce il chiaro legame esistente tra diverse discipline comprendenti salute pubblica, sicurezza e protezione; sicurezza e protezione alimentare, ambientale ed economica. L'applicazione dell'*intelligence *all'agricoltura è resa necessaria dalla rapidità di cambiamento nella società odierna, che comprende non solo la scienza e la tecnologia, ma anche il collegamento dei compiti di settori diversi ed il fatto che l'agricoltura è vulnerabile sotto diversi aspetti. L'*intelligence *applicata all'agricoltura associa impulsi provenienti da una vasta ed articolata gamma di discipline ed organizzazioni e promuove non solo un passaggio di informazioni ma anche un'analisi dell'informazione stessa. Tale analisi fornisce uno schema per prevedere attivamente eventuali pericoli, per una migliore e più profonda comprensione di tali minacce, lo sviluppo di una politica più informata e maggiori risultati operativi.*

Parole chiave

Agricoltura, Agri-intelligence, Eliminazione animale, Integrazione, *Intelligence*, Protezione alimentare, Salute ambientale, Salute animale, Salute pubblica, Salute vegetale, Sicurezza alimentare.

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Introduction

There are many definitions of agriculture. Some are very simple, such as 'cultivation of the soil and rearing of animals' (1). Others are very comprehensive and inclusive, listing activities which are associated with food or the 'handling, planting, drying, packing, packaging, processing, freezing, grading, storing or delivering to storage or to market, or to a carrier for transportation to market, or for direct sale any agricultural or horticultural commodity as an incident to ordinary farming operations, or, in the case of fruits and vegetables, as an incident to the preparation of such fruits or vegetables for market or for direct sale' (3). This definition includes forestry and wildlife as well as domestic animals.

An agricultural product is 'any product or commodity, raw or processed, that is marketed for human consumption (excluding water, salt and additives) or animal feed (4). Regardless of the definition, the words 'food' and 'agriculture' are inextricably linked.

The understanding or broad definition of agriculture may need to be enlarged as technologies including genetic engineering, nanotechnology and information technology advance. For example, 'molecular pharming' is a genetic manipulation of plants and animals which enables the production of vaccines, proteins and antibodies. Although these products are consumed, it may not be in the traditional manner or for the same purpose, that is, growth and maintenance, for which plant and animal products are traditionally consumed.

Agriculture has a significant impact on a nation's security because of its links to public health, food safety and security, environmental health and economic stability. Thus, threats and risks associated with agriculture can have an impact on these sectors. This is one of the main driving forces for the development of integrated agricultural intelligence or integrated agri-intelligence (IAI). Figure 1 illustrates the relationship between agriculture and national security.

The processes of intelligence include scanning, filtering, collecting, evaluating and analysing information and data to produce a value-added product or output which decision-makers may act upon to achieve the specific goals and objectives of their respective organisations.

This paper defines IAI, describes the elements which contribute to it and discusses the benefits it provides as a specific field in intelligence.

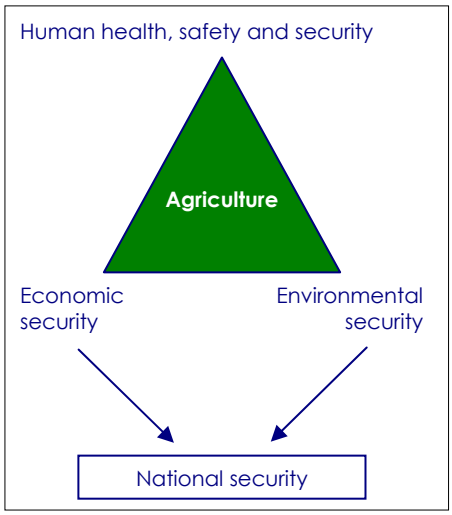


Figure 1
Agricultural intelligence and national security

What is integrated agri-intelligence?

Integrated agri-intelligence is the product of analysis of information, data, events and issues related to a broadly defined agriculture sector. The inputs to IAI come from many different organisations and multiple units within each organisation. The organisations that contribute to IAI form a network to which each provides information related to their field. The information and data thus provided by contributors are analysed to produce intelligence which is in turn used by the contributors.

Any organisation with a link to agriculture may contribute to IAI. These organisations include those involved in:

- public health
- agriculture, animal health, plant health and plant production
- environment

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- organisations related to some aspect of the food chain such as processors, transportation and providers
- public safety and emergency management
- intelligence and security
- criminal (organised crime, etc.) investigation and enforcement
- border security and customs
- national defence
- central government agencies.

Each organisation provides inputs related to its mandate and work. There are many specific units within each of these organisations that can contribute to IAI. Several specialised units may exist in a single organisation. These units include the following fields:

- medical sciences
- biological sciences
- physical sciences
- social sciences
- intelligence
- counter-intelligence
- surveillance
- risk analysis
- criminal investigations
- emergency planning and operations.

The range of contributors in the network is one of the unique features of IAI. An important aspect is the merging of science-based sectors and the traditional intelligence field. This 'lab coat meets trench coat' approach means that the two diverse fields will begin to use and understand a common language and vocabulary. This creates synergies and opportunities to build on and reinforce complementary skills, knowledge and expertise. The members exchange and analyse information, which produces superior intelligence to that which would have been produced in isolation.

The benefits to all are that there can be a comprehensive analysis of all of the diverse and broad information which is supplied to the network and which produces integrated agri-intelligence. The relationship between IAI and contributing organisations and between the kinds of inputs from these organisations into IAI is illustrated in Figure 2.

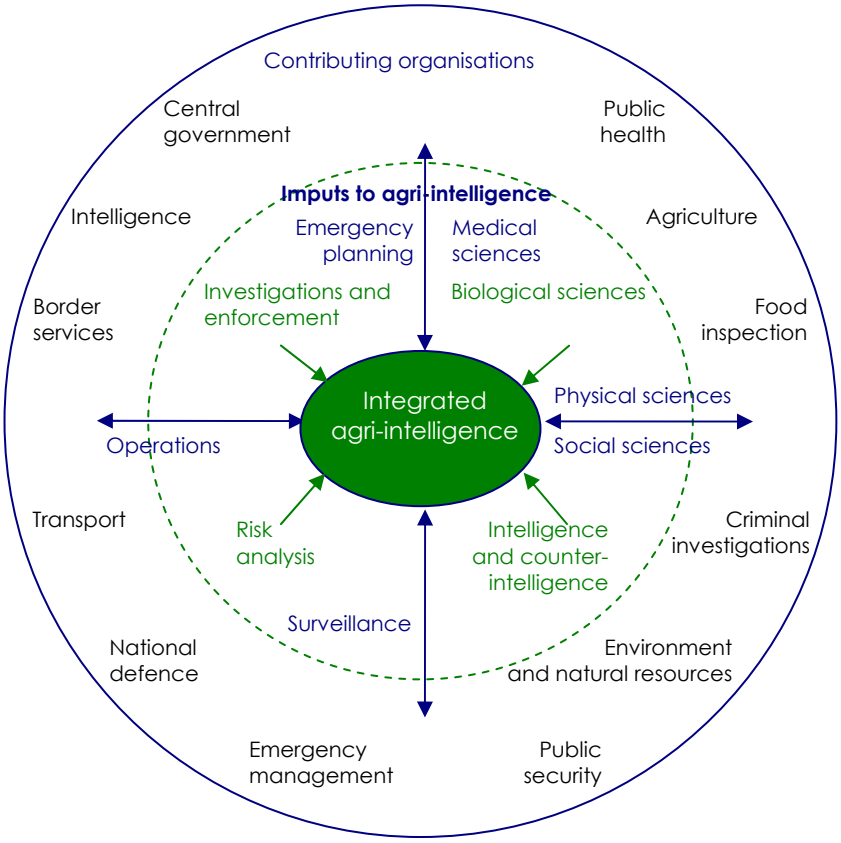


Figure 2
Organisations and their inputs to integrated agri-intelligence

Decision-makers are assisted by IAI in their work. The goals of decision-makers may be multiple and diverse and their respective core businesses may be very different. However, in one aspect or another, the core business of each has a link to agriculture.

Why do we need integrated agricultural intelligence?

Integrated agricultural intelligence is an approach to information sharing and analysis which allows different stakeholders, linked through agriculture, to share information, learn to speak a common language and integrate their analyses of events and situations. The need for this kind of approach is increasing in importance for many reasons, of which the following three are considered very important, as discussed below.

The globalisation of risk

The world is changing very rapidly and we cannot afford a lag period in our understanding of the impacts and implications of these changes. Table I identifies some of the factors that have an impact on agriculture and how these factors have changed in the last 35 to 40 years.

In the early 1970s, globalisation was a recognised driver of change. Now the forces of globalisation represent the status quo. However, globalisation is linked to both opportunity and risk. Agriculture is an area where this globalisation of risk is evident. Animals, plants and food move much more freely across borders and there is a greater demand for these products as demographics change in countries. These products may carry disease, pests, pathogenic micro-organisms and other contaminants which represent a threat to humans, animals, the environment and the agriculture sector.

The events of September 11, 2001 mark a discrete point in time when the world's awareness of terrorism changed – probably forever. After World War II, the world closely followed the global development of nuclear capability. Nuclear weapons, with their massive capacity for destruction were viewed as a major threat. This is still true today and is illustrated by the reaction of world leaders to the development of nuclear capability in North Korea (2).

However, there are perhaps even more serious threats to mankind. Science and technology have developed so rapidly that it is now a foreseeable reality that humans will be able to

Table I
A comparison of factors which have had an impact on agriculture, from the mid-1980s to 2006

Element	Mid-1980s	2006
Globalisation	Driver of change	Status quo – may even be a push-back from some sectors
Terrorism	Low visibility, local	High visibility, global
Nature of threats	Traditional, nuclear weapons at worst	Non-traditional, new life forms
Access to information	Moderately easy but greater in developed countries	Extremely easy and globally distributed
Speed of information transfer	Fast	Faster
Communications	Traditional – television, telephone, newspaper, etc. Still in growth phase of the information age	Much more sophisticated – cell phones with text messaging, cameras, videos Mature information age
Access to advanced technology	Moderately easy	Extremely easy
Demand for information	High	Unbounded
Crime	'Traditional'	'Traditional' but new forms enabled by science and technology
Public demand for safety and security	Increasing after a period of relative calm in post-WW II	Very high public fear of perceived and real risks

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engineer new life forms. The production of new biological weapons with unpredictable characteristics is a real threat today.

The report of the National Academies, entitled *Globalisation, biosecurity, and the future of the life sciences, states*, 'The Committee on advances in technology and the prevention of their application to next generation biowarfare threats, an ad hoc committee of the National Research Council and Institutes of Medicine, was constituted to examine current trends and future objectives of research in the life sciences, as well as technologies convergent with the life sciences enterprise from other disciplines such as materials science and nanotechnology, that may enable the development of a new generation of biological threats over the next five to ten years, with the aim of identifying ways to anticipate, identify and mitigate these dangers' (7).

In his book, *The World is Flat*, Thomas L. Friedman, argues that around the year 2000, globalisation entered 'a whole new era'. The unique aspect of this new era was the 'newfound power for individuals to collaborate and compete globally. And the lever that is enabling individuals and groups to go global so easily and so seamlessly is not horsepower, and not hardware, but software – all sorts of new applications – in conjunction with the creation of a global fiber-optic network that has made us all next-door neighbors' (6).

The ease of access to information and the speed of communication aid terrorists in their activities. An article in the newspaper, the *Globe and Mail* dated 11 January 2007, reported on the conviction, by a Bosnian court, of three terrorists, charged with plotting a suicide terror attack. All three were deemed to be at the center of an Internet-based international network of home-grown terror cells spanning London, Copenhagen, Dhaka, Atlanta and Toronto (5). The director of a United States-based anti-terrorism Web service, told the *Globe and Mail* that, 'the Internet is a place, and terrorists dwell in that cyberspace and use it as a virtual safe haven' (5).

Not only is biotechnology advancing at an accelerating rate, the 'global spread of expertise in biotechnology and biological manufacturing processes raise concerns about how this advancing technological prowess could enable the creation and production of new biological weapons and agents of biological terrorism processing unique and dangerous but largely unpredictable characteristics' (7).

Naím states that not only is illicit trade on the rise, it is more complex than it has been since the Atlantic slave trade (11). He believes that there are serious illusions concerning illicit trade. 'First is the illusion that there is nothing new' (11). In fact, there were many social, cultural and economic changes in the 1990s which promoted changes. 'Changes in political and economic life, along with revolutionary technologies in the hands of civilians, have dissolved the sealants that governments traditionally relied on to secure their national borders. At the same time, the market-oriented economic reforms that swept the world in the 1990s boosted incentives to break through these sealants – legally or otherwise' (11).

'Technology enlarged the market, not just geographically by lowering transport costs but also by making possible the trade in a whole range of goods that didn't exist before, such as pirated software or genetically modified marijuana. New technologies also made it possible to trade products internationally that in the past were hard or impossible to transport or hold in "inventory" – human kidneys for instance. Markets, of course, were also enlarged when governments deregulated previously closed or tightly controlled economies and allowed foreigners to visit, trade, and invest more freely' (11).

The North American baby boomer generation had parents who took part in the global conflicts of WW II. They were content with the security and safety of the post-war world. These baby boomers essentially grew up in a world where they did not have to take part in global conflict. The attacks of September 11, 2001 were doubly devastating for North Americans. They had never seen an attack of this magnitude on their soil.

The complexities, commonalities and interconnectedness of many sectors require an integrated approach

The concepts of convergence, commonality and interconnectedness may be a major global theme in the next fifty years. These terms can be applied across science and technology fields, such as nanotechnology, biology and medicine and within fields, such as public health or agriculture. However, these concepts will also have to be integrated across sectors which traditionally may not have seen the need to interact. Bioterrorism, for example, has confirmed the realisation that national defence and biological science sectors must work together more closely than ever.

Nanotechnology may provide a 'broad technological platform' for applications in many areas, including: bioprocessing, molecular medicine, investigation of the health effects of nanostructures in the environment and eco-toxicology, improving food and agricultural systems and improving human performance (13).

Marano *et al.* state that there has been a long-standing gulf between animal health and human health agencies and that they must learn to cooperate in order to combat emerging microbial threats (9). 'The daily interactions of humans, animals, and the environment have a dramatic impact on public health' (8).

The impacts on public health due to these interactions of humans, animals and the environment, are not limited to disease events. 'Recent events have brought the relationship between animal and human health into much sharper focus than even public health and veterinary health specialists might have predicted' (14). Animal diseases may be important because they are zoonotic. However, disease outbreaks and the control measures which accompany them may have a significant psychological impact on farmers and the veterinary personnel who perform these measures, have a serious environmental impact associated with disposal, and challenge acceptable standards of animal welfare (14).

Integrated Agricultural intelligence is a concept which encompasses the many sectors which interact with or are important to agriculture and upon which agriculture has an impact. It also encompasses the idea of interconnectedness of sectors and the multidimensional nature of intelligence related to agriculture.

Table II illustrates how different organisations would use agricultural intelligence for their own mandates. An outbreak of the Asian strain of highly pathogenic avian influenza, H5N1, in a flock of migratory birds for the first time in country, is the example used.

Vulnerability of agriculture

Agriculture is vulnerable on many fronts. Not only is it vulnerable to natural events and the activities of humans who may intentionally or unintentionally threaten it but also because of the manner in which it is organised and the infrastructure on which it depends. Threats to agriculture have consequences for many sectors. Some of these consequences may be so detrimental to society that they may result in a backlash against agriculture should any of them occur.

Natural and man-made forces that contribute to the vulnerability of agriculture include the following threats:

- natural events, for example, floods, droughts and severe adverse weather events
- global warming and its impacts, such as climate change which may lead to desertification, or the increase or change in geographic distribution of a disease vector
- newly emerging disease threats, for example, the highly pathogenic Asian strain of avian influenza, H5N1
- threats inherent in modern production methods, including large and intensive production units in which vast numbers of animals are reared in close proximity, creating a population that is highly susceptible to many disease agents
- infrastructure components, such as transportation, processing, inspection and distribution systems for which it is difficult to provide oversight and tracking
- intentional damage through bioterrorism or agroterrorism
- accidents related to biotechnology or release of agents from a laboratory

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- increased movement, both legal and illegal, of animals, people and products
- energy and water shortages
- political instability and global conflict
- increasing world population and urbanisation, resulting in greater numbers of people to feed and fewer having the resources to produce their own food
- economic consequences related to decreasing consumer confidence as a result of real or perceived threats
- social values and standards which perceive agriculture in a negative light, for example proponents of animal rights.

A discussion paper by Public Safety Emergency Preparedness Canada states that, 'The agri-food sector constitutes a highly vulnerable economic flank in Western countries' (12). Natural disease outbreaks in the recent past, such as the foot and mouth disease outbreak in the United Kingdom, cost billions of dollars and affected multiple sectors.

In developed countries, only a small segment of the population faces a shortage of food. Thus, food security is not a significant problem; in fact, poor nutrition and over-nutrition are more likely to be areas of concern. Food safety is a greater concern in developed countries. However, situations may arise in both developed and developing countries which threaten food security as well as food safety.

Benefits

The benefits associated with integrated agri-intelligence are related to the three key factors described below.

Advantages inherent in a comprehensive, multi-dimensional network

The value of human networks has been recognised for a long time. The key to maximising the investment in a network is 'to think hard about exactly what kind of value you want the network to create' (10). Integrated agri-intelligence requires inputs from multiple partners, with different perspectives and inputs. The value is well defined. It is to improve the anticipation of and response to issues and events of concern which are related to agriculture, in the broad sense of the term. It is a mechanism to stay 'ahead of the wave', to be proactive in identification of issues and response to events.

The members of the network share information related to their expertise and

Table II
The impact on different government departments of an outbreak of the Asian strain of avian influenza H5N1

Department or agency	Areas of potential impact associated with the event
Public health	Human health
Agriculture and Food Inspection Agencies	Food security Food safety Animal health and production Economic Trade restriction
Environment and natural resources	Migratory birds and other susceptible wild species Endangered species
Public security and emergency management	Overall management of associated emergencies
Intelligence and security	Possible terrorist links/activities
Criminal investigations and enforcement	Possible links to organised crime
Border security	Smuggling of contraband (animals or products) across borders
National defence	Possible terrorist links/activity which threatens national security
Central government agencies	Economic Political International
Transportation	Movement of diagnostic specimens

mandates and thus the information is more complete and comprehensive than it would be without the network. Members learn to speak a common language. Analyses are performed in collaboration and shared by the entire group. Relationships are built in advance of problems, such as disease outbreaks and, therefore, at the time of an emergency, the communication pathways have already been developed and are operational.

Increased efficiency and effectiveness for each individual contributing organisation

The individual organisations that contribute to IAI benefit from the shared analysis. They have superior intelligence on which to base decision-making, programme and policy development and operational activities. Each organisation derives benefits that exceed the intelligence received from the integrated analysis. These benefits are related to the internal dialogue and communication which must take place within the organisation. Units that feed the network from within one organisation must become more aware of the work which is ongoing in the organisation to ensure that the most important information is being forwarded to the network. Thus, within the organisation, there will be greater communication between units dealing with diverse areas, such as risk assessment, emergency management, science, operations, intelligence and others.

Possibility of enhanced outcomes in each phase of emergency planning and management

Integrated agri-intelligence is valuable in each of the four phases of emergency planning and management. The inputs to IAI, as illustrated in Figure 2, come from different functional units of organisations and the roles of these units differ in the four areas of emergency planning and management – anticipation and prevention, preparedness, response and recovery. These inputs are the raw material for the production of intelligence. However, the intelligence which is produced informs all of the units which provide inputs to the network. For example, risk assessments performed by an animal disease risk assessment unit are informed by the work of the country's border services which monitor activities such as smuggling of contraband. The risk assessment will provide information to aid in the design of a surveillance programme. If the surveillance is for a zoonotic disease agent, public health organisations could be placed on higher alert.

Conclusions

All the forces that have an impact on agriculture will have an impact on food safety, food security, food quality, public health, environmental health, public security and economic security. These forces are multiple and diverse and are the responsibility of many different organisations.

Of the many and diverse scenarios which may develop, inputs from several different organisations will help in the development of intelligence to prevent, mitigate, respond and recover from such a situation. These organisations must have established communication networks prior to the occurrence of an event in order to develop an understanding of the role of the other organisations, open communication channels and build trusting relationships.

Networks are an outstanding mechanism to share information and to perform collaborative analysis. All the parties with a stake in agriculture, regardless of how diverse, are advised to contribute to IAI in order to optimise the delivery of their individual mandates and to enhance national security.

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