R&D/Litbang untuk Inovasi pada Agroindustri

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Quote of the day

- We need to build a future in which our factories and workers are busy manufacturing the high-tech products that will define the century… Doing that starts with continuing investment in the basic science and engineering research and technology development from which new products, new businesses, and even new industries are formed.
- President Barack Obama, February 2012

Innovation - Definition

- Innovation is defined as the introduction of new or significantly improved products (goods or services), processes, organizational methods, and marketing methods in internal business practices or in the open marketplace (OECD/Eurostat 2005).
- The term "ecosystem" emphasizes complexity of the innovation process – one that is highly dynamic, has many interdependencies, and is always evolving.
- National investment in basic and applied research and development importantly contributes to the flow of market-based innovations in ways that can be characterized as an "innovation ecosystem."

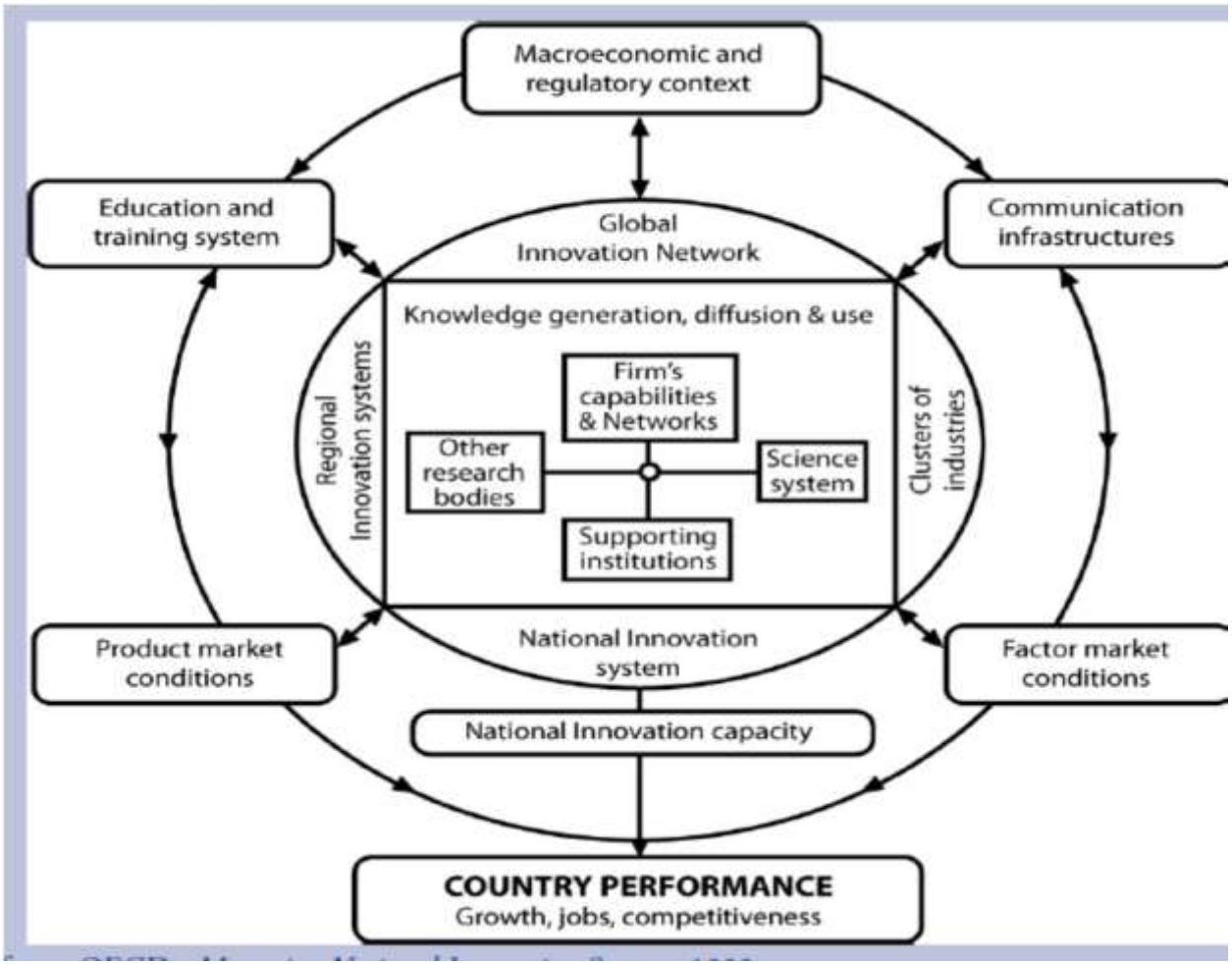
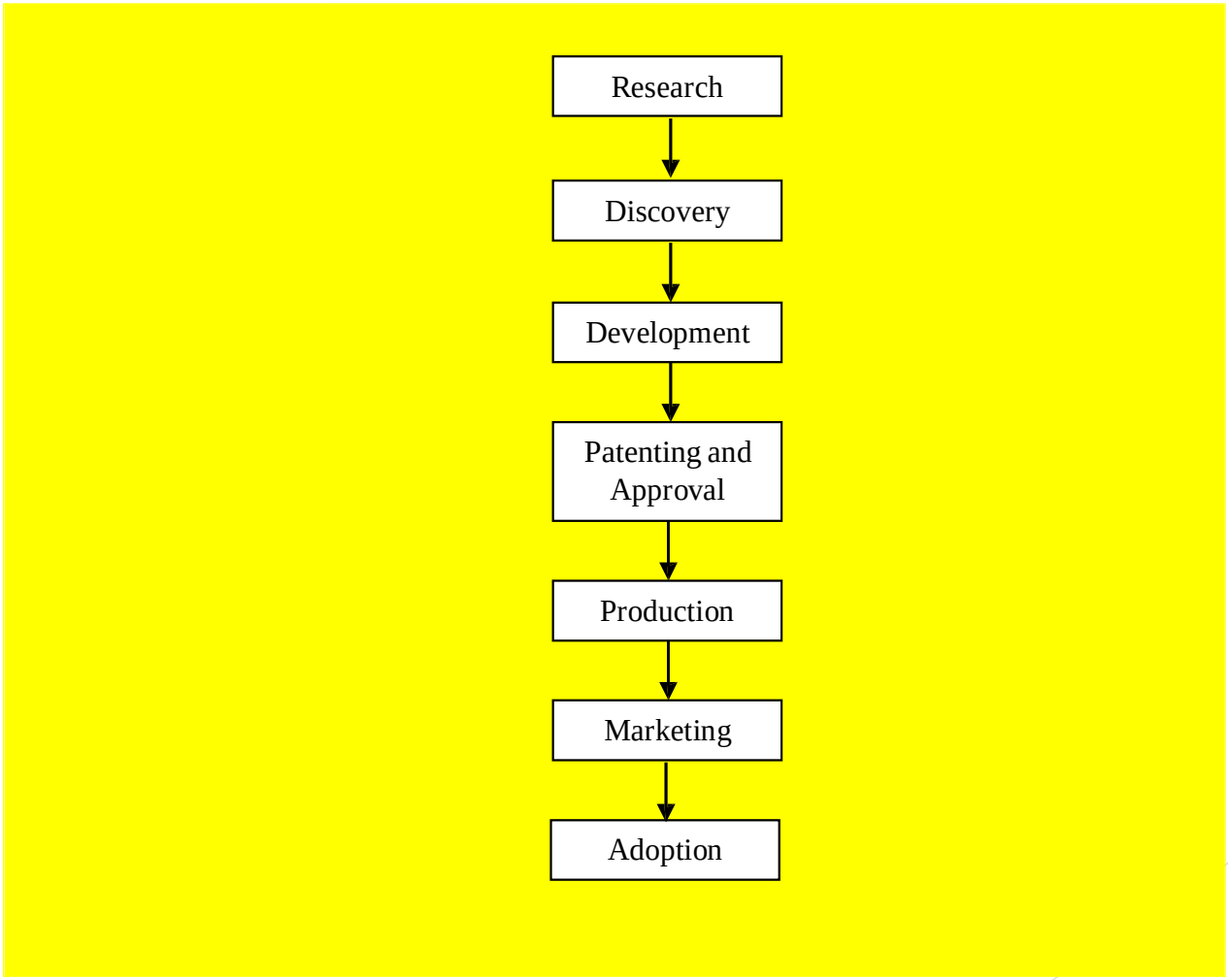


Fig. 1. The Many Interdependencies of a national Innovation system (Adapted from: OECD. Managing National Innovation Systems, 1999.)

The Innovation Process

- An innovation starts as a concept that is refined and developed before application.
- Innovations may be inspired by reality. The innovation process, which leads to useful technology, requires:
  - Research
  - Development (up-scaling, testing)
  - Production
  - Marketing
  - Use
- Experience with a product results in feedback and leads to improved innovations.

The Innovation Process



Technology Adaptation and Appropriateness

- Rarely is the same technological solution optimal everywhere. The value of an innovation depends on socio-economic,climatic, and ecological specifics.
- Important innovative activities adapt technological solutions to specific conditions.
  - Export of technologies across regions without adaptation may lead to negative environmental side effects and waste.
- A technology may have several versions to meet needs and capabilities of various users in a region, e.g., large vs. small farmers' versions of a machinery.
- The establishment of an innovative capability starts with a buildup of capacity to support and adopt innovations and new technologies.

Induced Innovations

- Innovations respond to need and economic conditions. Inventors, investors, and researchers put effort into solving burning problems, and that leads to innovations.
  - Labor shortages led to mechanized equipment.
  - Drought conditions led to improved irrigation.
  - Energy crises led to higher efficiency cars.
  - Farmers' cooperatives were established during periods of excessive low farm prices.
- Environmental regulations trigger cleaner technologies.
  - A tax on carbon will lead to improved stoves and power plants.

Various Types of Innovators

- In the past most innovations were introduced by practitioners. Even now practitioners are important innovators. They identify a way to meet needs.
- The scientific discoveries of the late 19th century gave rise to science-based innovations (Edison, Bell, Marconi).
- Major companies (IBM, Sony, Bell, Kodak, GM) built their own research labs.
- Public sector labs made important agricultural and environmental discoveries.
- Universities and start-up companies are becoming major sources of new innovations. The ownership of a technology and leadership in its applications move between organizations over time.

Incentives for Innovations

- Patents: Awards monopoly rights for 17-20 years.
  - Patent protection allows publication of research findings that leads to innovations.
  - Patent rights (for certain applications) can be transferred.
  - Patents are valid only where they are registered.
- Copyright protection: Pertains to books, brand names, and the media.
- Trade secrets: Protects against thefts.
- Plant breeders' right: Allows exclusive sales of varieties and allows farmers to reuse seeds.
- Prizes: Awarded to winners of a contest for finding a technical solution to a problem.
- Indigenous knowledge is poorly protected.

Intellectual Property Rights and Development

- Investments in R&D and new products will be much lower without the expected monopoly gains.
- Local industry and foreign investors benefit from patent protection, as is already the case in India.
- IPR constraints may inhibit domestic companies' ability to develop new products.
- Added IPR knowledge may lead to gains:
  - Production for local markets does not require obtaining rights to patents that are not registered locally.
  - Developing countries can trade access to bio-diversity for access to technology. They can reach special agreements with universities and companies.

Investment in Research: A Key Element of Environmental Policies

- Research enables discovery of basic environmental problems. Without research, not much would have been known about the link between smoking and cancer.
- Research provides better monitoring and management equipment to help identify environmental problems and monitor response.
- Public research enables sustaining development of technologies that may not be economical under existing prices.

Division of Labor

- Basic research: Gain more comprehensive knowledge or understanding of the subject under study, without specific applications in mind. Conventionally conducted by universities.
- Applied research: Apply knowledge. Often conducted by industries.
- Educational-industrial complex: University research has led to the creation of new firms and even industries, brought old ones down, and, in general, profoundly impacted rates of innovation in the larger economy.

Stakeholders in the Innovation Process

- Universities, including research scientists, university administrators, and designated officers of technology transfer.
- Entrepreneurs, including start-up companies and venture capitalists.
- Incumbent corporations.
- Potential technology adopters and downstream producers who will use the technology
- Government regulators.
- Environmental and other special interest organizations.
- Consumers.

Why Universities Do Not Do What Companies Do and Why Companies Do Not Do What Universities Do

1. Uncertainty: Uncertain outcome of basic research.
2. Inappropriability or 'nonmarketability': Some results from basic research are not appropriable, because they occur at such fundamental levels of scientific analysis.
3. Spillovers: Some results from basic research can easily spill over to competitors in the same line of business that the results may actually help the competitors more than they help the company that conducted the initial research.

Institutional Arrangements: Incentives to University Researchers

- Formulas for the allocation of OTT revenues from license royalties:

  -Most common formula: Equal sharing among the university (33%), the department (33%), and the employee inventor (33%).

  -Another common formula: 50%-50% sharing between the university and the inventor.

  -Average net revenue distributions: University (35%), department (25%), and faculty inventor (40%).

Adoption and Diffusion

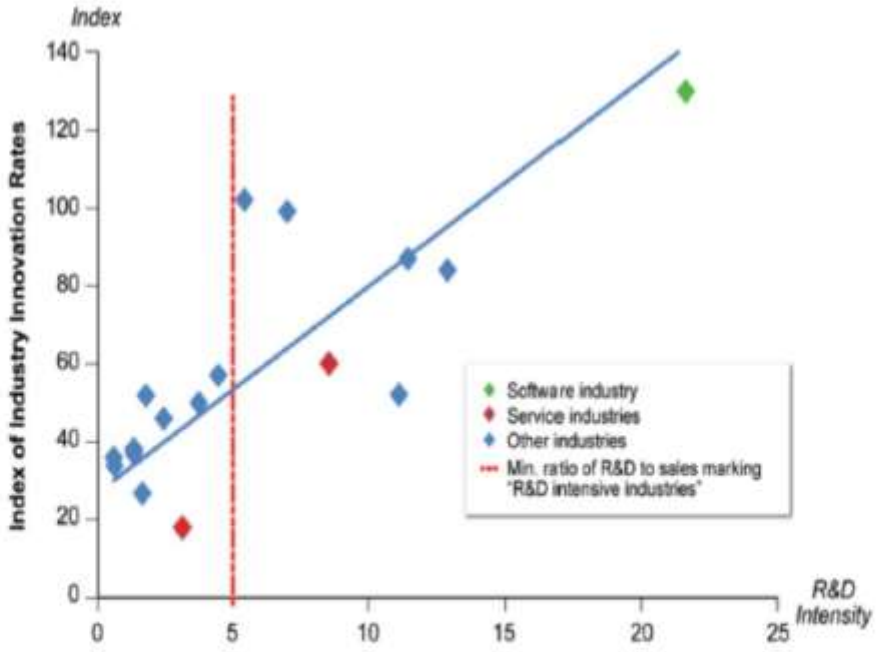
- The use of new technologies spreads gradually.
- There is a significant time lag between the time a new innovation is introduced and when it becomes widely used by producers or consumers.
- Diffusion is the aggregate process of product penetration.
  - It is measured by the percentage of potential users who actually adopt a technology.
- Diffusion curves measure aggregate adoption as a function of time. They tend to be S-shaped.
- Adoption is a decision by a specific individual to use a technology. Diffusion is aggregate adoption.

Role of Innovation

- Innovation driver of economic growth.
- Innovation leads to new and improved products and services, higher productivity, and lower prices.
- Economies that have consistently high levels of innovation also tend to have high levels of growth (Atkinson and McKay 2007).

R & D and Innovation

- R&D and other intangible investments such as investments in software, higher education, and worker training are key inputs driving innovation.
- Investment in R&D is not synonymous with innovation.
- Companies that perform or fund R&D have a far higher incidence of innovation than companies without R&D activity.
- The relationship between R&D and innovation is highly complex (Fig. 2).

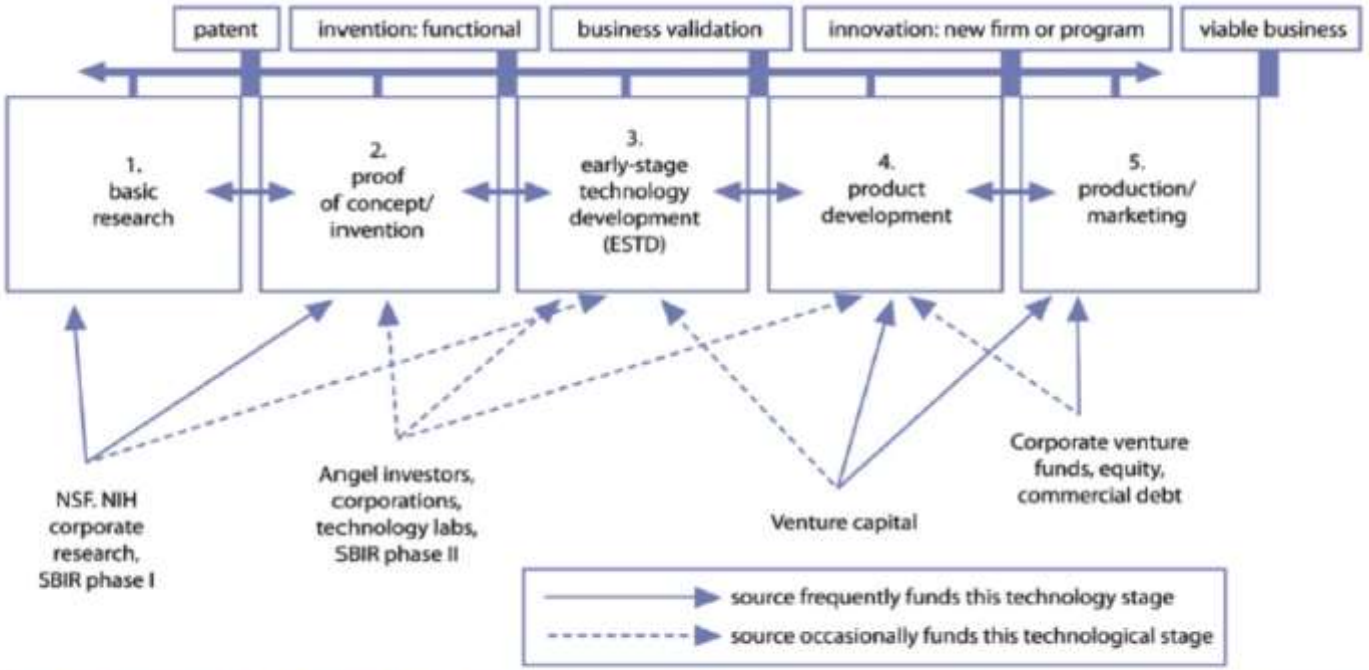


Adapted from: Gregory Tassey. *Beyond the Business Cycle: The Need for a Technology-Based Growth Strategy*, 2011.

- Fig. 2. Rate of Innovation vs. R&D Intensity Percent of Companies in an Industry Reporting Product/Process Innovation

R & D and Innovation

- Innovation does not necessarily require progression through all steps in a successive, linear fashion, but rather there are multiple “entry points” to this process (Fig.3).
- Overlap and redundancy increase the chances that an innovative idea will be funded to bring the idea from the invention stage to release as a new product or process in the marketplace.



Adapted from: Branscomb, L.M. and P.E. Auerswald. *Between Invention and Innovation: An Analysis of Funding for Early-Stage Technology Development*, 2002.

Fig. 3 "Upstream" and "Downstream" Steps Linking Research to Design and Product Development

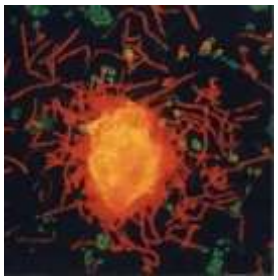
Budget allocation for R&D

- Business sector investment focuses largely on development, directing almost 80% of its R&D resources toward development, compared to only 13.9% toward applied research and an estimated 5% towards basic research (USA in 2009). Development funding generally supports incremental rather than transformative innovation.
- Transformative innovation is more likely when basic research leads to quantum steps in expanding knowledge or through synergies when progress in multiple areas of science or technology complement each other to provide new composite capabilities.

Innovation and Research Strategy for Growth

Four priority areas for policy making:

- Driving research and innovation in all sectors of the economy: low- and medium-tech as well as high-tech
- Creating a more coherent and integrated research and innovation system
- Improving innovation performance by intensifying the roles of the science, research and information infrastructures
- Ensuring that the public sector is a major driver of innovation

Industrial Strategy: Key sectors

Advanced Manufacturing

- Aerospace
- Automotive
- Life Sciences

Knowledge-intensive traded services

- Professional / business services
- The information economy
- Further and Higher Education

Enabling Industries

- Energy
- Construction

Industrial Strategy: Horizontal strands

Technologies:

- Support emerging technologies, systematically identifying those with the most potential (working with TSB, Research Councils and Foresight).
- Support longer term investment in research and innovation.

Procurement:

- Develop a coordinated approach to strategic procurement across the whole of government.

Skills:

- Deliver STEM and related skills pipelines to meet the needs of tomorrow's economy.

Access to Finance:

- Proposing the set up of a government-backed institution to increase diversity in the supply of finance and institutions which provide a coherent relationship banking service to viable growing businesses.

Increase of competitiveness

Through :

- Knowledge generators that would create new technologies
- Research results transferred to industry, market valued
- Knowledge Transfer in Universities – to the market
- Financing the innovation: Business Angels, Venture Capital
- Transferable technologies towards the economic environment
- Intellectual property; Patents
- Personnel trained (Technology Transfer and Innovation, technology brokers)
- Innovative SMEs with high added value
- Promotion, formation of a mass innovation culture
- Etc

Agro-industry

- Agro-industry provide a means of converting raw agricultural materials into value added products while generating income and employment and contributing to overall economic development in both developed and developing countries
- Example:

  Food processing converts relatively bulky, perishable and typically inedible raw materials into more useful, shelf-stable and palatable foods or potable beverages.

  Processing contributes to food security by minimizing waste and loss in the food chain and by increasing food availability and marketability.

  Food is also processed to improve its quality and safety.

R&D, Innovation in Agro-industry

- Biotechnology as applied to food processing makes use of microbial inoculants to enhance properties such as the taste, aroma, shelf-life, texture and nutritional value of foods fermentation.
- Fermentation processing is also widely applied in the production of microbial cultures, enzymes, flavours, fragrances, food additives and a range of other high value-added products.
- Fermentation is often one step in a sequence of food processing operations, which may include cleaning, size reduction, soaking, and cooking.
- Microbes associated with the raw food material and the processing environment serve as inoculants in spontaneous fermentation,
- Inoculants containing high concentrations of live micro-organisms, called starter cultures, are used to initiate and accelerate fermentation in non-spontaneous or controlled fermentation processes.
- Microbial starter cultures vary widely in quality and purity.

R&D, Innovation in Agro-industry

- Fermentation processing as practised in most developing countries is more art than science, and, in low-income economies, often makes use of a rudimentary technological base with poor process control, resulting in low yields and products of variable quality.
- Spontaneous fermentations and those which make use of "appropriate" starter cultures produced largely through backslopping (a process which makes use of samples of a previous batch of a fermented product as inoculants) are widely applied at the household and village level in developing countries.
- With increasing research and development, a number of precultured single or mixed strains of micro-organisms, called "defined starter cultures", have been developed and are being used by small manufacturers in their fermentation processing operations.
- Defined starter cultures are also imported by a number of developing countries for use in processing operations.

R&D, Innovation in Agro-industry

- Traditional methods of genetic improvement such as classical mutagenesis and conjugation can be applied to improve the quality of microbial cultures.
- Hybridization is also used for the improvement of yeast strains.
- Recombinant gene technology is widely employed in research and development for strain improvement.
- While these techniques are common in developed countries, they are only now beginning to be applied in developing countries for the improvement and development of starter cultures.
- For example, random amplified polymorphic DNA (RAPD) techniques have been applied in Thailand in the molecular typing of bacterial strains for the production of a fermented pork sausage with differing flavours. The results of these analyses have led to the development of three different defined starter cultures, which are currently used for the commercial production of products with different flavour characteristics.

R&D, Innovation in Agro-industry

- Genetically modified (GM) microbial cultures are used in the production of enzymes and various food processing ingredients.
- Rennet, which is widely used throughout the world as a starter in cheese production, is produced using GM bacteria.
- Thailand currently makes use of GM Escherichia coli as an inoculant in lysine production.
- Many industrially important enzymes such as a-amylase, gluco-amylase, lipase and pectinase, as well as bio-based fine chemicals such as lactic acid, amino acids, antibiotics, nucleic acid and polysaccharides, are produced in China using GM starter cultures.

Thank you