



What is WGS?

WGS is one of the new laboratory tools that reveals the complete DNA make-up of an organism. The simplicity, precision, speed and flexibility of WGS provide advantages over the multiple traditional methodologies combined. With the rapidly declining cost, WGS has the potential to renew the approach in managing various issues in the food and agriculture sectors.



Whole Genome Sequencing (WGS) for food safety

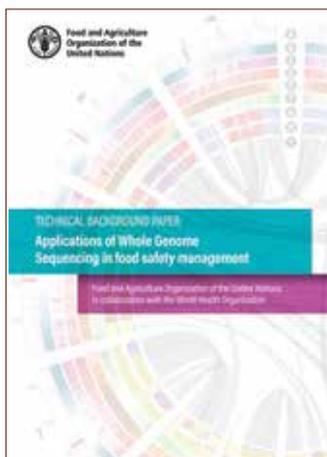
FOOD SAFETY AND WHOLE GENOME SEQUENCING

Food safety is a global concern (FAO 1996¹) and the current estimated global burden of foodborne disease from microbiological food safety problems and the related social and economic costs remain unacceptably high (WHO 2015²). Some newly emerging tools that can be useful in managing such food safety problems have become increasingly sophisticated. However, challenges remain in outbreak investigations, in linking illness to particular foods and ensuring the appropriate products are recalled. WGS is one such tool that offers great potential for various food safety regulatory activities including food inspection, outbreak detection/investigation and studies on antimicrobial resistance (AMR). Such benefits would significantly contribute to protecting public health and food security as it eventually saves lives and prevents economic losses and food waste from incorrect or imprecise implications of wrong products and commodities. However, while several industrialized countries have been moving forward with WGS for food safety management, its application, particularly in developing and transitional countries, is limited.

APPLICATIONS OF WGS IN FOOD SAFETY MANAGEMENT

FAO took the first step in addressing the gaps in the different levels of understanding of the concepts and potential use of WGS in food safety management among different countries (<http://tiny.cc/WGS-TP>). Four real-life case studies were developed and they highlighted key benefits and potential drawbacks of WGS in food safety management (left box). The cost of WGS has been identified as both a benefit and a potential drawback. Some studies have found WGS to be less expensive than existing systems (Joensen et al., 2014 and ECDC FWD-Next report, 2015)³. On the other hand, in countries where there is no suitable mechanism in place for WGS, implementing the technology requires a high cost in setting up and maintaining the environment for effective WGS application (Lindsey et al., 2016)⁴.

In the **United States**, the real-time WGS-based health surveillance and food monitoring for *Listeria (L.) monocytogenes* led to the rapid identification of the source of illness, more precise and faster than traditional subtyping methods. The regulatory response to this was significantly accelerated and additional cases likely prevented. In **Denmark**,



Technical paper on the
applications of WGS in food
safety management (FAO, 2016,
<http://tiny.cc/WGS-TP>)

Benefits of WGS

- Specificity
- Sensitivity
- Cost
- Speed
- Universality
- Ease of learning and use
- Ease of sharing
- Flexible and amenable to reanalysis
- Greater confidence in decision making
- Easier access to trade and markets

¹ FAO. 1996. World Food Summit. Rome, Italy. Website (available at http://www.fao.org/wfs/index_en.htm). Accessed 14 June 2016

² WHO. 2015. WHO estimates of the global burden of foodborne diseases: foodborne disease burden epidemiology reference group 2007-2015. Geneva, Switzerland. Publication (available at http://apps.who.int/iris/bitstream/10665/199350/1/9789241565165_eng.pdf) Accessed 14 June 2016

³ Joensen, K.G., Scheutz, F., Lund, O., Hasman, H., Kaas, R.S., Nielsen, E.M. & Aarestrup, F.M. 2014. Real-time whole-genome sequencing for routine typing, surveillance, and outbreak detection of verotoxigenic *Escherichia coli*. *J. Clin. Microbiol.*, 52(5): 1501-10. <http://dx.doi.org/10.1128/jcm.03617-13>.

⁴ Lindsey, R.L., Pouseele, H., Chen, J.C., Strockbine, N.A. & Carleton, H.A. 2016. Implementation of Whole Genome Sequencing (WGS) for Identification and Characterization of Shiga Toxin-Producing *Escherichia coli* (STEC) in the United States. *Front Microbiol.*, 7. <http://dx.doi.org/10.3389/fmicb.2016.00766>.

Drawbacks

- Cost
- Data storage
- Infrastructure requirement
- Data handling and transfer
- Interpretation of WGS data
- Sustainability
- Possible imbalance of trade opportunities
- Trust issues for data sharing
- Need for surveillance and food monitoring systems



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Technical Meeting on the impact of Whole Genome Sequencing on food safety management within a One Health framework



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Discussions with experts from developing countries

routine food and environment monitoring for *L. monocytogenes* together with health surveillance using WGS succeeded in linking apparently sporadic cases over a long time period and the underlying outbreak source was identified and eliminated. In a **England**, a WGS-based investigation identified the root cause of a *Salmonella* outbreak and prevented future outbreaks. This case study also highlighted the importance of the availability of WGS data from multiple countries, demonstrating how global sharing of WGS data could enhance the response to international foodborne outbreaks, to further protect public health and identify a particular source of contamination. The experience shared by **Kenya** showed the potential usefulness of WGS in developing countries, however having WGS data in itself was not sufficient and there was a need identified for a significant amount of advocacy and understanding of both advantages and possible disadvantages of using the technology in countries with limited capacity and resources.

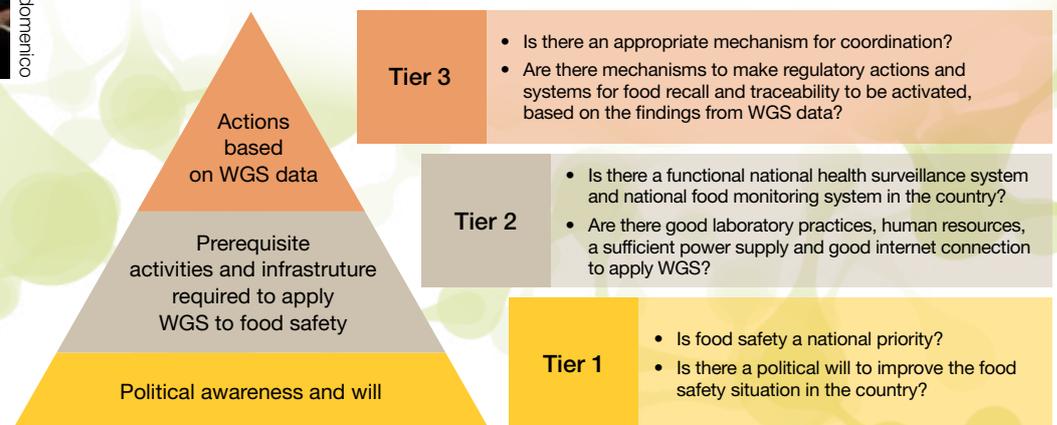
CHALLENGES IN USING WGS FOR FOOD SAFETY MANAGEMENT

Overcoming the challenges and ensuring that countries can reap the benefits of WGS means that all parties need to be involved in the dialogue regarding its use in food safety management. To facilitate this, FAO convened a global meeting bringing 175 participants from 50 countries to the table, half of which were developing countries (<http://tiny.cc/FAO-TM>). While recognizing concrete advantages of the technology, concerns around liability and accountability that are legally binding, in respect of WGS data, were raised and the need for legal basis for harmonized and accredited typing methods was highlighted. Further, as participants realized that WGS without effective data-sharing has almost no value, some suggested that competent authorities may face various challenges in balancing protecting intellectual property rights and facilitating access to data for the global good. The quality of WGS data needs to be assured with transparent validation and certification, thus this creates additional work. Sustainability may also be a challenge as newer ways of enhancing WGS may continue to improve, thus, regular reviews and updates on methodologies may be necessary.

IS WGS FOR YOUR COUNTRY?

As with any new tool, the real benefits are only realised if it is embedded in the appropriate infrastructure. Figure A provides an overview of how a basic feasibility study can be undertaken by countries considering the use of this technology to support their food safety programme.

Figure A. Step-by-step approach and example questions for feasibility study



FOR MORE INFORMATION CONTACT:

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