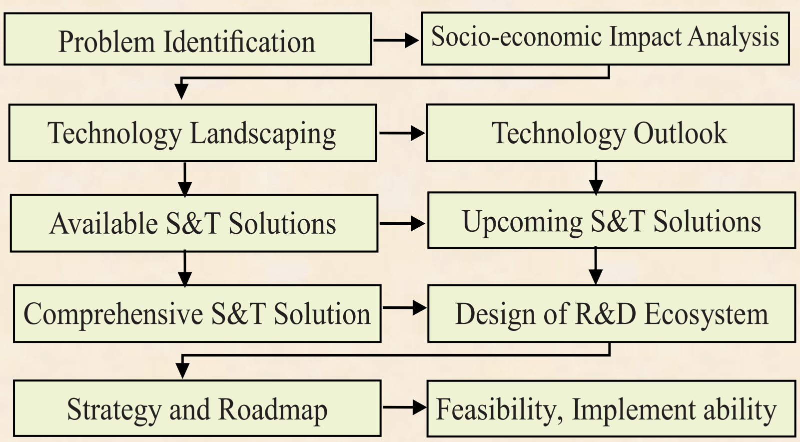
NISTADS/NTPR/2017/1

CSIR - NISTADS MISSION
STAPP - S&T APPLICATIONS TO PEOPLES' PROBLEMS

SUMMARY

STAPP aims to systematically recognise and prioritize peoples' problems where S&T can provide effective solutions. The identification is made objective as far as possible, using traceable quantitative parameters like the number of persons affected, geographical coverage, socioeconomic strata and the severity. Some S&T solutions are outlined based on available literature; similarly, a first-level technology outlook is provided for R&D planning. It is expected that the challenges thrown by STAPP will open new and promising areas of innovation. STAPP is thus meant to supplement and complement, and strengthen our conventional S&T research, not replace it.

STAPP - THE PROPOSED APPROACH



THE PARADIGM OF STAPP

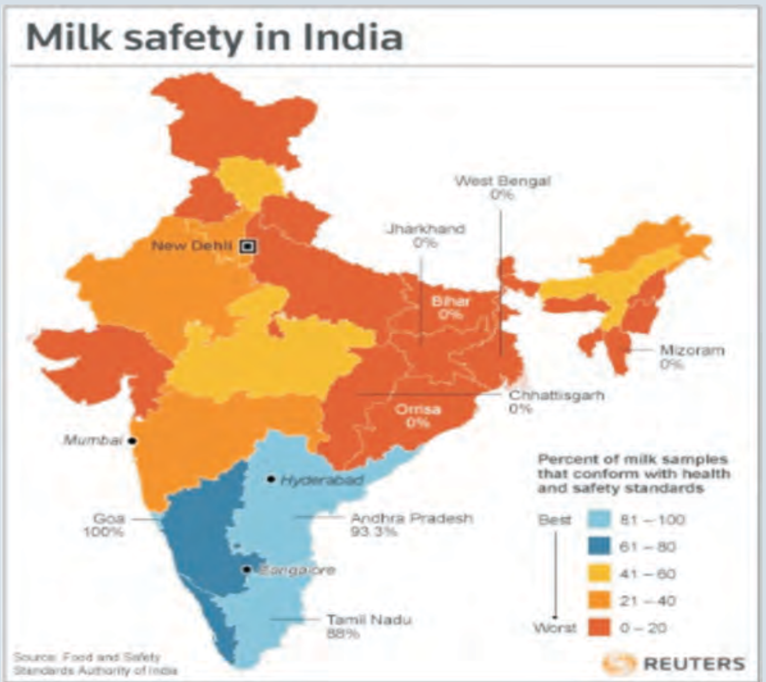
The Prime Minister of India and the President, CSIR had emphasized the need for addressing problems faced by the people of India through S&T applications. While conventional discipline-centric R&D can be the cutting edge driving our progress and guiding civilization, matching efforts are essential to systematically and effectively translate the results of scientific inquiry to solutions to peoples' problems.

STAPP calls for a paradigm shift in the design of our R&D. The process of identification and prioritization necessitates integration of socio-economic impact analysis and technology landscaping as the first step. It also highlights the need for appropriate innovation and value addition to develop applicable and comprehensive solutions. To keep pace with the evolution of the problem as well as the S&T solutions, the effort has to be supported by sustained R&D and technology outlook.

STAPP Case study: ADULTERATION

Adulteration is a serious problem faced by the people; it affects many products due to bad practices by suppliers. S&T enabled detection and at-source prevention can help reduce adulteration; however, an integrated effort is required. The document provides a macro socio-economic impact analysis of adulteration followed by a global technology landscaping and technology outlook for addressing prevention of adulteration. Few S&T solutions are outlined basically drawn from the existing literature; also, a first-level technology outlook is provided for R&D planning. These are expected to provide inputs for design of an **Integrated R&D Ecosystem for Adulteration Detection (IREAD)** leveraging new techniques and tools; the conception being to integrate available disconnected efforts and facilities to create a virtual but connected network to provide point-of-care and supply chain monitoring in a cost-effective manner.

For detailed report visit - http://www.nistads.res.in/images/reports/stapp.pdf

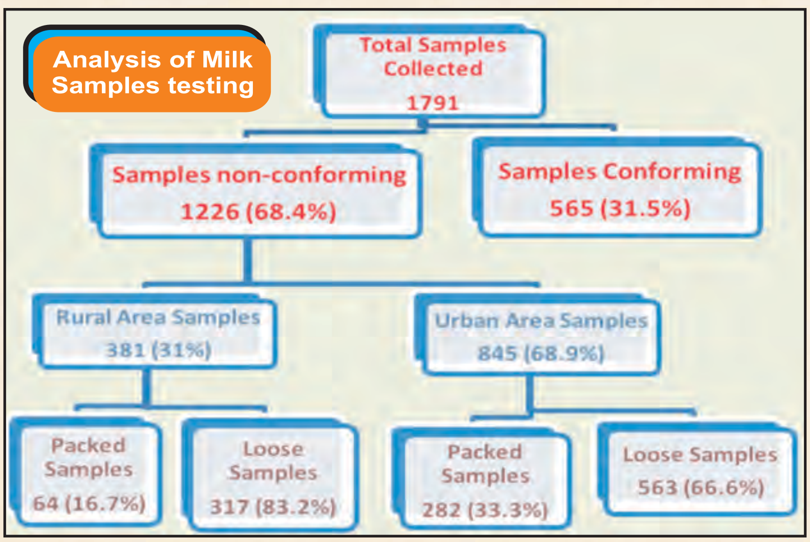


MILK ADULTERATION

As per National Survey on Milk Adulteration, addition of water to milk is the most common adulterant. Water reduces the nutritional value of milk; contaminated water may also pose health risk. Also powdered milk is reconstituted to meet the milk demand. The study also indicated the presence of detergent in some cases. Almost 70% of the milk sold and consumed is adulterated by contaminants

FOOD ADULTERATION

As per FSSAI, there has been a surge in cases of food adulteration during recent years. In 2014-15 survey, food adulteration was found in samples from all states/union territories. The ever increasing scale and complexity of food supply networks has made them significantly vulnerable to adulteration and contamination



Genuine (L) / falsified (R) hologram onartesunate blister packs

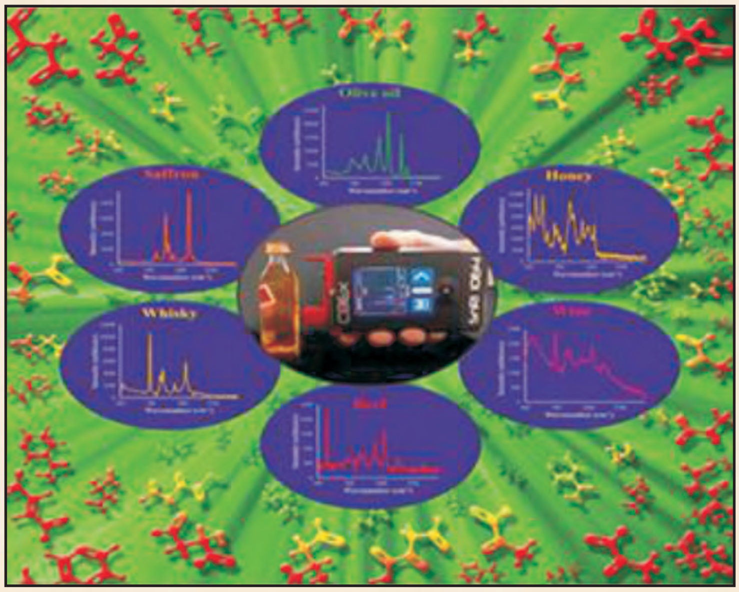
DRUG ADULTERATION

The problem of spurious or imitation drugs also exists in addition to adulteration.The Drugs and Cosmetics (Amendment) Act, 2008 provides deterrent penalties for offences relating to manufacture of spurious or adulterated drugs which have serious implications on public health.

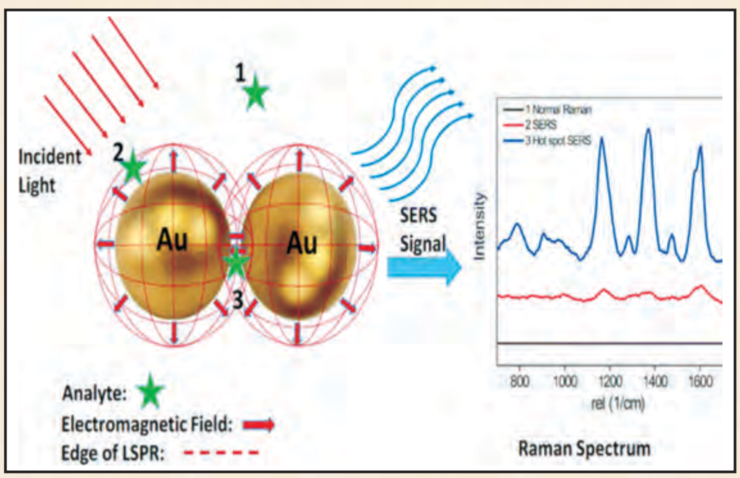
FUEL AND MATERIAL ADULTERATION

As per Ministry of Petroleum & Natural Gas, major Indian Oil Marketing Companies have detected malpractices including under-measurement and adulteration at their retail outlets in 2011-14 and terminated 160 retail outlets for such irregularities under Marketing Discipline Guidelines/ Dealership Agreement.

Manufacturers are legally required to give material information about the quality and constituents of the product and adhere to the laws and standards enforced by public authorities. But producers quash the information about the quality, purity, standard or performance of the material. Products are adulterated, or substandard raw materials are used for production of the goods for profits; violating the consumer rights and other laws.



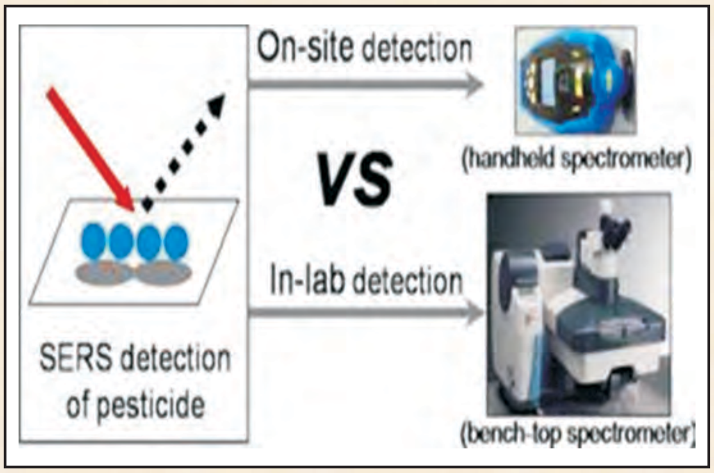
Commercially available Handheld Raman spectrometer/Range of Raman spectra



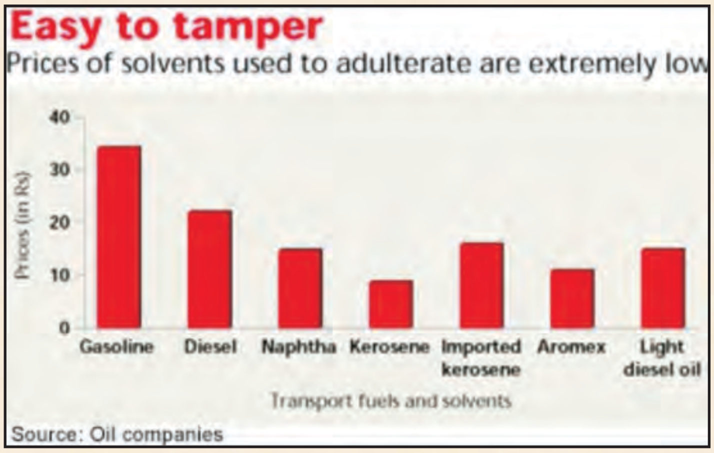
Schematic of SERS Phenomenon for an organic analyte on AuNPs

TECHNOLOGY LANDSCAPING

Several techniques have been developed for detection of adulteration based on colorimetry and spectroscopy. Mass spectrometry (MS) is a prevailing technology with many benefits and few limitations for applications within the food supply chain. It provides rich structural information and the precise molecular weight of the compound under investigation. MS offers high chemical specificity and sensitivity for example, enabling the accurate identification and quantification of known analytes within complex food matrices at very minute level of concentrations. The chromatography column chemistry needs to be carefully chosen to separate the complex components of food adequately.



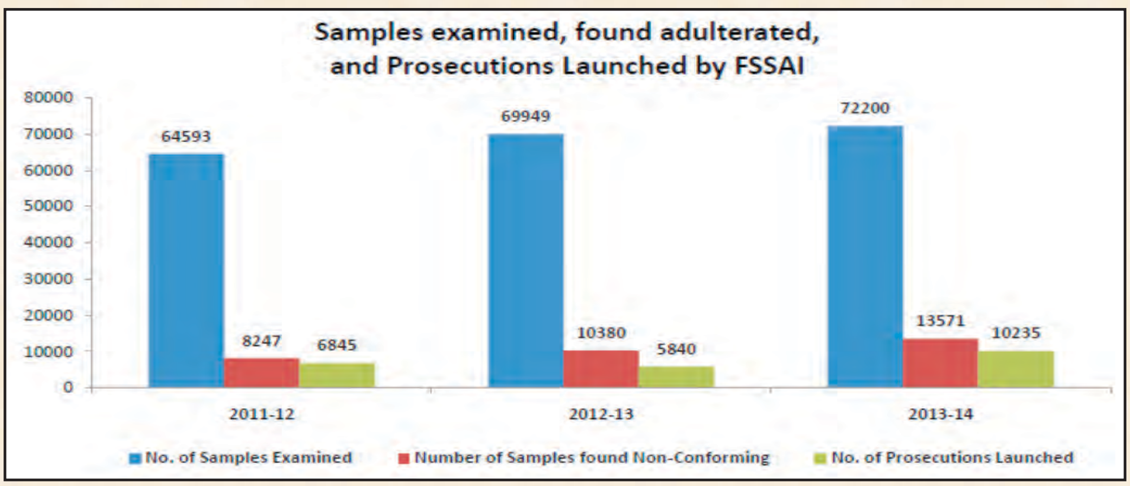
In-lab and on-site detection using Handheld Spectrometer



Low cost of solvents make Food Adulteration Easy.

SOCIO-ECONOMIC IMPACT

Food adulteration happens to be a major health hazard for people in day-to-day life Adulteration is found in food, milk, drug, fuel and material. As per Food Safety and Standards Authority of India (FSSAI) in 2014-2015, about 20% food samples were adulterated/ misbranded; and failed the test of quality and branding regulations, which is much above the internationally accepted 5% failure in testing.



TECHNOLOGY OUTLOOK

Forensic chemistry techniques can give information on the unique fingerprints that manufacturers leave on their products. It can provide the authorities evidence necessary to tie falsified drugs to particular sources; however, such sensitivity is still expensive. Techniques to analyze pharmaceuticals include - visual inspection of product and packaging; tests for physical properties such as disintegration, reflectance spectroscopy, and refractive index; chemical tests including colorimetry and dissolution; chromatography, spectroscopic techniques; and mass spectrometry. Improved colorimetric–SERS method has been used to rapidly screen and validate melamine in milk, as low as 0.25 ppm, within 20 minutes. Integrating colorimetric and SERS methods exploits the advantages of both, and provides a more rapid, accurate, and cost-effective way for monitoring melamine contamination.

Handheld Raman Spectrometer

Ksheer Scanner CSIR-CEERI

TECHNOLOGY INTERVENTION

Technologies can protect consumers and also help generate accurate estimates of the magnitude of the problem. Raman spectroscopy is useful technique, which has been made portable by many manufacturers. The suitability and utility of portable/ handheld Fourier Transform Infrared (FTIR) spectroscopy within the food supply chain has become increasingly evident. In addition to the relatively stable and restricted laboratory setting, portable and handheld spectroscopy has already proven effective in the more challenging and lively surroundings of the food supply chain. Innovative technologies to detect falsified and substandard drugs are constantly emerging. Making detection technology more accessible is invaluable to controlling the trade in falsified and substandard drugs.

Major Recommendations
Integrated R&D Eco-system for Adulteration Detection (IREAD)

Adulteration detection is increasingly dependent on emerging tools like Internet of Things and Data analytics. A comprehensive and sustained R&D ecosystem is needed to address the problems of adulteration detection in an inclusive manner. It would be cost-effective and efficient to develop a structure with multi-disciplinary expertise; adulteration detection draws techniques from science, engineering as well as computer science.

IREAD: CONCEPT AND RATIONALE

- Spread of technologies and tools in adulteration detection in various sectors is relatively small and requires similar expertise and infrastructure.
- IREAD would be cost-effective to optimum utilization of the available R&D infrastructure.
- The ecosystem would involve components like infrastructure, equipment, experts, technicians and support staff for end-to-end and product driven R&D on adulteration; industry and academia will be important external components.
- IREAD is implementable, especially within an agency like CSIR, through a virtual R&D network enabled by Internet of Things.
- IREAD can enable development of innovative detection, sampling and analytical technologies, ranging from field and rapid screening technology to sophisticated lab-based assessments.

IREAD: Structure and Roadmap

India's R&D for adulteration detection is distributed in various institutions/university departments; these isolated efforts might add up to complete solutions.

To identify organisations with existing/similar mandate. Develop/ translate/ adopt new and emerging methods and technologies.

Pooling of R&D expertise through scientists in deputation, making IREAD financially feasible.

Detection process to be integrated to the supply chain so that adulteration becomes financially and operationally unacceptable to the likely offenders.

For further information
Director, CSIR-NISTADS
Dr. K.S. Krishnan Marg, PUSA, New Delhi-110012
Phone :(+91)-011-25843227;(+91)-011-25846064(Direct)
Fax:(+91)-011-25846640, Email:director@nistads.res.in