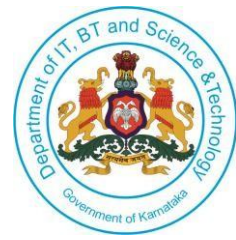


COVID-19: Strategy and Way Forward for Karnataka



**Karnataka Science and Technology Academy
Department of Science & Technology
Government of Karnataka**

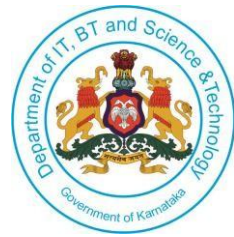
&

**Planning, Programme Monitoring &
Statistics Department, Government of Karnataka**

Strategy Paper

COVID-19: Strategy and Way Forward for Karnataka

Based on
State Webinar on
COVID-19: Strategy and Way Forward for Karnataka
19 June, 2020
Bengaluru



**Karnataka Science and Technology Academy
Department of Science & Technology
Government of Karnataka**

&

**Planning, Programme Monitoring &
Statistics Department, Government of Karnataka**

July, 2020

Convenors: Prof. S. Ayyappan, Dr A.M. Ramesh & Sri V.G. Umesh
Karnataka Science and Technology Academy

Dr (Smt.) Shalini Rajneesh, IAS & Dr (Smt.) Chaya Degaonkar
PPMSD, Government of Karnataka

Citation: KSTA & PPSMD, Government of Karnataka, 2020.
COVID-19: Strategy and Way Forward for Karnataka,
Strategy Paper No. 1, Karnataka Science and Technology Academy,
Bengaluru, 37 pp.

KSTA Executive Committee 2020-2023

Prof. S. Ayyappan, Chairman
Dr E. V. Ramana Reddy, Member
Dr Prakash M. Sobarad, Member Secretary
Prof. H. A. Ranganath, Member
Prof. K. Balaveera Reddy, Member
Prof. B. G. Mulimani, Member
Prof. S. K. Saidapur, Member
Prof. V. G. Talawar, Member
Prof. A. H. Rajasaab, Member
Dr A. E. Eknath, Member
Dr D. Channe Gowda, Member
Prof. Katre Shakuntala, Special Invitee
Prof. H. S. Savithri, Special Invitee
Dr A. M. Ramesh, Convenor

Published by

Karnataka Science and Technology Academy

College of Horticulture Entrance, GKV Campus,
Major Sandeep Unnikrishnan Road, Vidyaranyapura Post, Bengaluru 560097
Tel: 080-2972 1550; Email: ksta.gok@gmail.com; Website: www.kstacademyin

Preface

We are well aware of the unprecedented global biotic disaster in a century, the COVID-19 pandemic, impacting every single moment and act of all of us. Lives have been lost, agriculture, education, industry, communication, transportation, tourism, banking and so on. Each sector has different kinds of challenges, with varied impacts. The COVID-19 pandemic has caused an unprecedented human and health crisis. The measures necessary to contain the virus have triggered an economic downturn. The effects lockdown period have been severely felt because the production, consumption, exchange and other interdependent economic activities have crippled industry at the national level and within the States. Losses of employment and income have severely impacted the workers in the informal (including unorganised) sectors and poorer families who are unprotected by statutory social security measures.

Individuals and Institutions are putting their best, experiences, expertise, learnings, skills to combat the situation, both to survive and grow. Global, regional, national, state level and local protocols, procedures, measures and steps are being continuously designed, implemented, evaluated, modified, refined, with science, technology, innovations, social and economic interventions.

In this long term disaster management, we need to discuss the way forward, not only with regard to our health, but also survival, that encompasses all sectors of economy. With this in view, the Planning, Programme Evaluation and Statistics Department of the Government of Karnataka and Karnataka Science & Technology Academy, a Unit of the Department of Science and Technology, Government of Karnataka, organised a multi-stakeholder meeting, with presentations from Health Experts and participation of representatives from different areas of Education, Agriculture, Industry, Economy, Disaster management and related aspects, on Friday, 19 June, 2020. These have resulted in the present Strategy paper for Way Forward in the context of COVID-19, for the State of Karnataka.

We are grateful to Shri B.J. Puttaswamy, Hon'ble Vice Chairman, State Planning Board, Govt. of Karnataka for inaugurating the meet; Dr E. V. Ramana Reddy, IAS, Additional Chief Secretary, Higher Education, Electronics, IT, BT, S&T, Government of Karnataka; Dr C.N. Manjunath, Director, Sri Jayadeva Institute of Cardiovascular Sciences & Research, Bengaluru; Dr Akash Prabhune, Consultant (Health), Centre for Public Affairs & Centre for Open Data Research, Bengaluru; Dr Alope Kumar, Faculty, Indian Institute of Science and Dr Santosh Ansumali & Dr Meher Prakash, Faculty, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru; Dr Chaya Degaonkar, Additional Chief Evaluation Officer, KEA, PPMDS, Government of Karnataka, for their presentations and remarks that served as the base for ensuing discussions. We thank all the leading experts from different fields for their participation in the Meet and valuable inputs, that have enabled the formulation of the Strategy paper. We hope this paper would provide for key interventions in times to come, as also serve as a reference for further discussions and action plans.

(Shalini Rajneesh)
Addl. Chief Secretary,
PPMSD, Govt. of Karnataka

(B.J. Puttaswamy)
Vice Chairman
State Planning Board

(S. Ayyappan)
President, KSTA

20 July, 2020

COVID-19: Strategy and Way Forward for Karnataka

I. Introduction

The economic disruption caused due to the COVID-19 pandemic in most countries across the globe has devastated millions of lives, while jeopardizing decades of development progress. Several reports and experiences of various dimensions of the pandemic and its impact on society are emanating from all over the world. The World Health Organization has declared COVID-19 as a pandemic, the first one in the 21st century. There are already 12 million infections and over 550,000 deaths globally, and the number of infections continue to rise. While several attempts to develop therapeutics and vaccines are underway, non-pharmaceutical interventions of various degrees such as wearing masks, social distancing, and lockdowns have been the only way of containing the pandemic to date. Even as it is evident that large scale lockdowns will have adverse effects on the economy, it has been the option that helped reach a high degree of control over the spread of the infections.

The 4 Ts - Tracing, Tracking, Testing & Treating are being deployed in the country and State too, with the RT-PCR tests of samples collected through nasal swabs being scaled up continuously. A substantial amount of infections is also being transmitted through asymptomatic individuals, their infectiousness profiles being harder to track. The concept of herd immunity is receiving attention in the recent past, that is when sufficient fraction of the population develops immunity, either due to infections or due to vaccines and the spread of new infections halts. With vaccines not available as of now and the requirement of about 50% of the population to be infected for the herd immunity to emerge, the focus is now to contain the pandemic through the measures mentioned above and public interventions like lockdowns, containment zones, movement restrictions and soon.

Some of the commonly used epidemiological models divide the population into three different groups, viz., Susceptible, Infected and Recovered (SIR) and study the dynamics across them, that have guided many lockdown programmes. Governments and public health modelers are analyzing the effectiveness of various strategies, starting from complete lockdown to reduced social contact and subsequent release of restrictions in a phased manner. As months go by, several factors are likely to change, the spread of infections due to the change in virulence, weather, human behavioral patterns, possible availability of vaccines, changes in mortality due to improved management or an overload of health care systems. It is also important to have adaptive strategies to deal with the pandemic before its peak or to avoid a resurgence after its peak, that need to be developed by constantly updating the models based on the available data.

The socio-economic impacts of the pandemic are being analysed globally and the World Bank and other Agencies have been providing the outlook for emerging food systems, manufacturing, service, markets and developing economies. The economic weight of the cultural and creative sector, with culture's intrinsic value as an expression of humanity as a key to sustainable development is also visible. In India, Organisations such as NITI Aayog and FICCI have brought out SWOT analysis of the situation, with a need for cross learning

and converting crisis into an opportunity. As a timely intervention, the Planning, Programme Monitoring and Statistics Department of the Government of Karnataka and Karnataka Science & Technology Academy, a Unit of the Department of Science and Technology, Government of Karnataka, organized a meeting of experts from different walks of life, through video conferencing, on Friday, 19 June, 2020, during 11 am to 4 pm, to discuss 'Covid-19: Strategy and Way forward for Karnataka'.

II. Inaugural Session

Prof. S. Ayyappan, Chairman, KSTA, welcomed the guests and delegates to the meeting, (Annexures I & II), with a background of emerging concerns relating to the unprecedented COVID-19 pandemic. He outlined the details of the meeting on the 'Strategy and Way Forward for Karnataka', organised by the Planning, Programme Evaluation and Statistics Department of the Government of Karnataka and Karnataka Science & Technology Academy, a Unit of the Department of Science and Technology, Government of Karnataka. While Health is the focus with specific presentations, stakeholders from all areas of economy are present in the meeting.

Shri B. J. Puttaswamy, Hon'ble Vice Chairman, State Planning Board, Government of Karnataka, in his inaugural address, expressed concern over the safe exit of the people and the economy from the COVID-19 pandemic. He highlighted the plight of labour, in informal sector and migrant labour, the sufferings of farmers and the small producers, traders and businessmen in MSME sector. The labour force in Karnataka as of 2017-18 (Periodic Labour Force Survey, PLFS 2017-18) is 25.5 million and informal workers are 22.2 million in number constituting 86.9% of the total workforce in Karnataka. In construction sector, only about 8 lakh workers are registered and 22 lakh workers need to be re-registered and about 7.5 lakh workers do not have bank accounts. It is necessary to hold discussions with different stakeholders regarding filling of skill gaps due to exit of migrant workers, provision of basic facilities and documents, online platform for exchange of skilled/unskilled labour, as also safe return of migrant labour. The other two most affected sectors are Agriculture and Micro, Small and Medium Enterprises (MSMEs). He spoke of the issues of storage and marketing in horticulture, with e-marketing as a possible solution. Agro-processing clusters, Market Intelligence and enhanced jobs under MGNREGA are to be accorded priority. Assistance with working capital and subsidies to MSMEs, trades and enterprises in service sector was emphasised and the Chief guest expressed the view that the meeting would be a forerunner for planning an overall strategy for the State.

Dr Shalini Rajneesh, Additional Chief Secretary, PPMS, Government of Karnataka commended the efforts undertaken by the State in addressing Covid-19, including the strong grievance redressal mechanism working 24/7 to mitigate the problems. She further said that rural women entrepreneurs need to be trained in food and health-related enterprises, as also the local/indigenous industries promoted under the *Atmanirbhar* schemes. Skilling and reskilling of youth and unskilled workers are essential through PPP mode. Efforts are being made to establish skilling facilities and a Helpline for MSMEs in collaboration with UNDP. With the education system disturbed significantly, the future design of education system, digitization, access and quality need to be addressed. The State Planning Board and the Department are also revisiting the strategies for attaining SDG targets in view of the COVID-19 pandemic. Young scholars are invited to contribute analytics and ideas through special

Internship programmes, where they are connected with SDG expert groups through webinars. The present meeting has representation from all walks of life to evolve a strategy for safe life and steady revival of the economy.

Dr E. V. Ramana Reddy, Additional Chief Secretary, Higher Education, Electronics, IT, BT, S&T, Government of Karnataka suggested measures for ensuring safe health for all. The IT/BT Department is designing innovative solutions for solving the problems of migrant workers, along with digital solutions for the emerging challenges in higher education and skilling through digital solutions. Emphasising on the collaboration between different agencies, he complimented the S&T inputs of several Institutions in Bengaluru for COVID-19 management and stressed on Good Management Practices in all sectors of economy, that the present meeting would deliberate upon, for formulating a strategy.

III. Presentations

Dr C.N. Manjunath, Director, Sri Jayadeva Institute of Cardiovascular Sciences & Research, Bengaluru; Dr Akash Prabhune, Consultant (Health), Centre for Public Affairs & Centre for Open Data Research, Bengaluru; Dr Aloke Kumar, Dr Santosh Ansumali & Dr Praksh Meher, Faculty at IISc & JNCASR, Bengaluru made presentations on the COVID-19 pandemic in the State including aspects of Health, Logistics and Projections. Dr Chaya Degaonkar, Additional Chief Evaluation Officer, KEA, PPMSD, GoK discussed the impact on Karnataka economy and the challenges in developing the road map.

1. Dr C.N. Manjunath, Director, Sri Jayadeva Institute of Cardiovascular Sciences & Research, Bengaluru (Annexure III)

Dr C.N. Manjunath, Director, Sri Jayadeva Institute of Cardiovascular Sciences & Research, Bengaluru, also the Nodal Officer for COVID-19 management in the State spoke of the medical emergency across the globe due to the pandemic. To curtail the menace of spreading this virus, Government of India as well as the State Government have taken several precautionary measures such as Lockdown, Containment Zones, Sealing down high risk zones, apart from advising other measures such as Social Distancing, Wearing of mask, Thermal scan and hand hygiene, etc. The whole objective of the Lockdown is not only to prevent the spreading of virus, but also for preparedness with respect to health, infrastructure, manpower and mobilization of resources and also to understand the natural history of this disease.

Various innovative methods were adopted using technology such as on line training of Doctors and Health care workers for COVID-19 management, remote thermal scans, tele-consultations and remote ICU management. Quarantine watches have been tracking the movement of positive cases and testing Kiosks within fever clinics and mobile lab testings played a significant role in early diagnosis and quarantining and Isolating. The Karnataka Government has aggressively implemented the lockdown as well as containment area seal down. Even during partial relaxation of lockdown, as there is a high risk in the containment zone, they were sealed off.

The preparedness of both the Teaching hospitals as well as District Hospitals was reinforced by adding Ventilators and supplying medical gadgets including high flow oxygen systems and adequate supply of PPEs, N95 masks, Sanitizers round the clock. The darker side of the lockdown is the closure of business establishments, hotels, restaurants, Industries, both small and medium scale, religious places, schools and colleges, factories, IT-BT and so on, which has resulted in loss of jobs, loss of lives, deduction in the salaries, etc. Another heart touching issue during the lock down period is the struggle of the migrant workers to reach their native places from work places. These call for a collective, comprehensive and collaborative action plan to support and stimulate various sectors, particularly the labour class. As there is a way existing from the lockdown, the prices of many essential commodities including diesel, petrol, construction materials and labour class is increasing which needs to be addressed.

The role of banking sector is extremely important to see how best they can support all the sectors which have suffered, most in terms of relief or defer payments of EMIs including waiving of interests. Several people would have taken loans for various properties and both agriculture and non agriculture sector are not in a position to pay the EMIs which is a matter of concern, since there is no production or business turn over in all the sectors. With GDP dropping and inflation going up, there is a need to infuse confidence to the public and promote travel and tourism which creates some jobs. Another important thing that needs to be addressed is to bring back the migrant labourers so that all concerned connected sectors can resume normal activities once there is flattening of the COVID-19 curbs.

The schools and colleges have been closed for a long time and it is unlikely they would open before August, 2020. Students as well as parents are under stress and a policy has to be evolved to conduct on line teaching including on line examinations. On line education has some disadvantages such as screen addiction which is one of main cause for the mental disorders. The work from home policy practice, particularly in IT-BT sector, used as an attractive healthier option, also has some health hazards. Health care professionals and other workers including ASHA and *Anganawadi* workers, Police and other field workers are providing selfless services risking their lives. Hence, a comprehensive action plan is required to both save lives and promote livelihoods.

Resource mobilization and revenue generation is also a priority. Farmers and labourers are the backbone of the country and need special attention. The governments can fight Corona only with the active support and cooperation from the public. The need of the hour is to provide Cash transfers to these sectors to tide over this period.

2. Dr Akash Prabhune, Consultant (Health), Centre for Public Affairs & Centre for Open Data Research, Bengaluru

Dr Akash Prabhune, Consultant (Health), Centre for Public Affairs & Centre for Open Data Research, Bengaluru informed that the Centre has brought out a series of reports to aid Government of Karnataka in decision making, readiness of health systems to tackle surge in cases and economic outline plan. They include Projections on cumulative cases across Karnataka; Clustering analysis to identify hotspots for better concentration of resources in

high incidence areas; Cases predictions and Detailed evidence-backed plan for restarting industrial and commercial activities in the state; while maintaining low incidence rate of COVID-19 cases.

The actual cases vis-à-vis predicted cases in the State are being continuously monitored. Further, multimorbidity modeling incorporating cases related to diabetes, hypertension, chronic obstructive pulmonary disorder, asthma, chronic kidney disease, ischemic heart disease, tuberculosis and HIV infection has been undertaken. Average recovery duration in days for individuals without any morbidity and those with any morbidity were 11.5; 11.5 days respectively, for those in the age group of less than 18 years; 15; 18.6 for 19-40 year age group; 17; 24 for 41-60 years; and 21.3; 29.4 for those over 61 years of age. It was deduced from the profile of COVID-19 cases in Karnataka that the requirement of ventilators is for only 0.5% of the cases. The analyses are being found useful in planning for hospitalization of patients in the pandemic.

3. Dr Aloke Kumar, IISC; Dr Santosh Ansumali, JNCASR & Dr Meher Prakash, JNCASR; Bengaluru (Annexure IV)

Dr Aloke Kumar, IISc and Dr Santosh Ansumali, JNCASR, Bengaluru presented modelling aspects of COVID-19, that has proven to be challenging not only because it is a novel coronavirus, but also because constraints such as social distancing and lockdowns are changing human behaviour in an unprecedented manner. A distinctive feature of the COVID-19, in contrast to other infectious diseases such as Influenza or SARS, is the presence of a large fraction of asymptomatic patients, who do not have any obvious symptoms but are still capable of infecting susceptible individuals through contacts. This means screening individuals by checking their temperature or symptoms serves the purpose only partly. The aspect of herd immunity was also discussed. The first wave of infections was contained during the lockdowns in Karnataka and two scenarios of a second wave of acute level of infections which may require an active and harsh Government intervention and a sustained level of infections that must be managed by having the responsibility shared by individuals and organizations were discussed.

A second wave of infections may be defined as a phase, hopefully hypothetical, where the infections will continue to grow exponentially. If and when a second phase arrives the effects of the first wave of lockdown may not be apparent, the infections may grow all over again, requiring forecasts of infections, overload of hospital facilities, etc. To prepare for this second phase, one will require two types of modelling efforts which will make these predictions. Successful long-term models need to capture not only the entire disease dynamics, but also account for policy interventions such as lockdowns. Before lockdown, the data points for Karnataka seemed to follow an exponential trajectory. Post-lockdown, this transitioned to an almost flat profile, which showcases the success of the lockdown. However, as the lockdown is being lifted, the curve has now transitioning again to an exponential curve. This suggests that a very aggressive contact-tracing and quarantining are required right now in order to contain the situation. Our group has created a model, which successfully captures the effects of lock-down and can be used for quantitative evaluations. infections, or predictions for many months depend on the both the behaviour of the virus and the people. In case of a second wave of infections, with exponential growth once again, one

may have to implement similar policies as were implemented in the first wave, the merits of each of which may be evaluated in a context-dependent way as the need arises, such as the strict enforcement of containment zones or District-wise lockdown implementation (DLIs).

The much discussed peak requires lockdowns in districts where infections are rising beyond control; travel bans from outside state regions which have exceedingly high infection rates; testing of people at railway station and airports. A perhaps less restrictive but more effective mode would be to test every person coming to Karnataka from outside, with a balance between opening the economy and keeping the safety of people.

When sustained low level of infections with no exponential growth occur, sources of infections have to be identified and characterized. Mitigation steps through policy interventions include establishing contact tracing protocols, advising firms to encourage work from home for people with senior citizens at home, Imposing limits on gathering sizes, limiting the number of people in public transport and other creative policy frameworks, that need to be continuously monitored and revised.

4. Dr Chaya K. Degaonkar, Addl. Chief Evaluation Officer, KEA, PPMSD, GoK

Dr Chaya K. Degaonkar, Additional Chief Evaluation Officer, KEA, PPMSD, GoK made a presentation on impact of COVID-19 on the economy of the State. The COVID-19 pandemic has caused an unprecedented human and health crisis. The effects lockdown have been severely felt because the production, consumption, exchange and other interdependent economic activities have crippled industry at the national level and within the States. Losses of employment and income have impacted the workers in the informal (including unorganised) sector and poorer families who are unprotected by statutory social security measures. Livelihood has been the critical issue for them as well as their dependents, especially if they are migrants or homeless. The State GDP at current prices (2019-20) is estimated at Rs 15,50,297 crore and therefore the average loss per day works out to be Rs 4,300 crore. The maximum loss is felt in Service sector that is a major contributor to State GDP (66%) as well as employment (47.44%), the other sector affected being Industry/manufacturing sector contributing 22.8% to State GDP.

The perceived effects and possible measures for addressing the issues in different sectors, viz., agriculture and agro-processing, industry including MSMEs, hospitality, tourism and service sector, labour including construction and employment, intra and interstate migration, education, skilling, gender and related aspects were presented. Sector wise plans and learnings from other States were also discussed.

IV. Discussions

The above presentations set the platform for remarks and discussions by the experts from different sectors (Annexure II). Dr Alex Thomas, President, NBAI; Dr Arvind, Health Expert; Dr B. S. Prasad, Health Expert presented their views on Health issues.

With regard to industry, economics and policy issues, Sri C.R. Janardhan, President, FKCCI, Bengaluru; Dr (Ms) Hema Swaminathan, Professor, Centre for Public Policy, IIM, Bengaluru; Dr (Ms) Jyotsna Jha, Head, Centre for Budget and Policy, Bengaluru; Dr Kishore Jahageerdar, Head, Karnataka Vision Foundation, Bengaluru; Dr (Ms) Smita Srinivas, Professor, NCBS and Centre for Technology Change, Bengaluru; and Dr P. Goswami, Chairman, IFSA, Bengaluru spoke on various issues in the present context.

Addressing the emerging issues in agriculture and related areas, Dr R. N. Srinivasa Gowda, Former Vice Chancellor, KVAFSU, Bidar; Dr K. Narayana Gowda, Former Vice Chancellor, UAS (B), Bengaluru; and Dr S. Rajendra Prasad, Vice Chancellor, UAS (B), Bengaluru proposed steps for mitigating the problems in farming across the State.

As regards Education, Dr Jai Asundi, Executive Director, CSTeP, Bengaluru; and Dr K. V. Subramanian, Consultant in Higher Education, Bengaluru discussed the current aspects and solutions. Dr H. Honne Gowda, Former Special Secretary, DST, GoK, Bengaluru; Dr K. Mukund Rao, Chief Executive, C-SAG, NIAS, Bengaluru; Dr S. G. S. Swamy, Consultant, VGST, DST, GoK, Bengaluru; and Dr Manjunath, Director, KEA, GoK highlighted the emerging issues in the COVID-19 pandemic and brought out S&T interventions. In a related reference to labour migration, Dr C.N. Prabhu, Scientific Officer, KSNDMC, Bengaluru suggested relevant relief measures.

From among the Members of the KSTA, Bengaluru, Prof H. A. Ranganath, Former Vice Chancellor, Bangalore University & Director, NAAC, Bengaluru; Prof. B.G. Mulimani, Former Vice Chancellor, Gulbarga University; Prof. A. H. Rajasab, Former Vice Chancellor, Tumkur University; Prof. Katre Shakuntala, Former Dean (Science) & Head, Dept. of Zoology, Bangalore University, Bengaluru; and Shri Nagesh Hegde, Eminent Science Writer, discussed various aspects of Education and Health.

Active interactions between the delegates led to several action points in different areas of economy in the State, with closing remarks by Dr Shalini Rajneesh, Additional Chief Secretary, PPMSD, GoK and Prof. S. Ayyappan, Chairman, KSTA. Dr Chaya Degaonkar, Additional Chief Evaluation Officer, KEA, PPMSD, GoK and Dr A. M. Ramesh, Chief Executive Officer, KSTA, Bengaluru proposed vote of thanks to the guests and delegates.

The presentations, discussions and further communications by the delegates, as well as published references in the intervening period have led to the following recommendations in different areas. Given the nature of the subject comprising several domains and multi-stakeholders, there are overlaps in suggestions that have been listed in different categories, but retained with an intent not to lose out on the ideas emanating from delegates from different backgrounds with varied experiences. It is also important to document each of them, for, the present pandemic is an event in a century and only a composite view of all the sectors can lead to a synergistic and comprehensive strategy for the State.

V. Recommendations

1. Health

Health & Family welfare have assumed unprecedented importance in the context of COVID-19 pandemic all over the world. Varied scenarios are unfolding in different countries as well as States in India, calling for urgent and customised responses. It has also led to learnings both in science and society and the Medical fraternity in Karnataka as well as Modelling experts have the following suggestions:

1. Priority for Flattening of Covid incidence curve; Random Testing of BMTC & KSRTC Staff, Medical Doctors & Healthcare workers, Municipality workers, Delivery boys, Vegetable vendors, etc.; Antibody tests; Installation of thermal scanners at railway and bus stations
2. Ensuring social distancing, wearing of masks and hand hygiene; Monitoring influenza like illness (ILI) and severe acute respiratory illness (SARI)
3. Strengthening government hospitals and primary health centres; Involving private hospitals in testing and treatment; Networking and online training for homecare facility system (NIMHANS model)
4. Use of both long term and short term (2-3 weeks duration) prediction models for emergency planning; use data pertaining to sustainability, exposure, infection, recovery and death
5. Due attention to Asymptomatic cases and monitoring recovery rates; Care of Non-Covid patients, with separate hospitals and treatment centres; Availability of general physicians; After schooling training in home health care
6. Private health sector to be given suitable guidelines for treatment of pandemics; Addressing the issues of private hospitals with government support, especially waiving off electricity and water charges
7. Single window approval for starting new hospitals; Service fare reimbursement and subsidised treatment; Telemedicine as an appropriate tool in the pandemic
8. Holistic approach in Healthcare by involving Allopathic and AYUSH forms of medicines; Promotion of Yoga and training of Paramedicals in Ayurvedic sector; Rejuvenation packages and preventive measures
9. Reassurance for health machinery and intense awareness for community participation; Due emphasis on nutrition for immunity development; Monitoring hospitality sector including hotels, restaurants
10. Adequate publicity to recovery cases; Possible use of University campii as Covid Care Centres
11. Need based Psychological counselling for all segments of society, both individual and collective; Reimaging institutions for comprehensive approach to the pandemic
12. Factual and motivational communication strategy, particularly for the vulnerable sections of the society, such as migrant labour, senior citizens, children through the parents
13. Use of new technologies, such as Robots for Covid patient care to reduce personal contacts; Capacity building on a large scale of Community Health practitioners & Volunteers, Municipal staff, Gram Panchayat and *Anganwadi* workers
14. Updation of citizen data base and publicising help lines for both horizontal and vertical redressals; Effective use of *Ayushman Bharat* facilities and PPP models under *Atmanirbhar* scheme; Active involvement of NGOs and Philanthropists, with open sources online designs
15. Aggressive contact-tracing and quarantining; Planned lockdown and containment zones implementation; Travel bans
16. Mitigation steps such as Establishing contact tracing protocols; Advising firms to encourage work from home for people with senior citizen at home; Imposing limits on gathering sizes; Limiting the number of people per public transport option and Other creative policy frameworks, to be continuously monitored and revised

2. Agriculture

One of the few sectors of economy that had moderate impact due to COVID-19 and continued to work despite hardships is Agriculture and related areas. Two aspects of reverse migration of people from cities to villages across the country as well as in the State and hardships relating to marketing of farm produce due to logistics issues stood out in this crisis. Further, leading Agricultural Scientists from all over the world sent an 'An Open Letter to the UN, G-20, and National Governments on COVID-19 and Agriculture for Food and Nutrition Security on 26 May, 2020' (Annexure V).

1. MGNREGA to incorporate farm activities including infrastructure required such as threshing yards, storage facilities for grains as well as perishables like fruits & vegetables; Synergy between different Departments of Food production, Agriculture, Horticulture, Animal Husbandry, Fisheries, Sericulture, etc.
2. Assessment of agri-workforce availability in the context of reverse migration and suitable reskilling of youth for remunerative farming and rural agro-based industries including value addition and primary processing, on the available model of ARYA (Attracting & Retaining Youth in Agriculture)
3. Cluster farming with community food crops and biofortified crop varietal propagation; Emphasis on Integrated Farming System and Precision farming; Secondary agriculture, urban farming, waste recycling in agriculture; More number of Custom Hiring Centres and farm mechanization as a group activity in the villages
4. Strengthening supply of farm inputs at farm gate on Swiggy-model for input supply; Empowering farm women and tribes; Enhanced micro-irrigation for smart farming
5. Enhanced processing and adequate cold storage facilities at catchment areas of perishables, particularly fruits, vegetables and fish, both stationary and mobile; Training of Self Help Groups in food processing technologies developed by CFTRI
6. New possibilities of Agri-Doctors for health management and farm guidance; More number of Farmer Producer Organisations (FPOs) and Agri-Start Ups; Customised training and extension programmes for both farm and off-farm activities, with *Raitha Mitras*
7. Investments in ICTs for both formal agricultural education and informal capacity building among youth for agri-enterprises, e-commerce and delivery companies; Promotion of Agriculture Infrastructure Fund for medium and long term debt financing of post harvest management and community assets projects
8. Identification of niche markets, brand development and training on agri-business management (Eg. *Ragi*, Millets, Turmeric, *Nanjanagoodu rasabale*, Mangoes, Tamarind, Silk, Honey, Coffee, Pepper, Copra and GI tagged products - Green Cardamom, Coorg Mandarin-Oranges, *Byadgi* Chilli, *Bababudangiri* arabica coffee, etc.)
9. Building effective collaboration between animal and human health services and response capabilities for tackling pandemics, as corona infection in animals is

known for a long time; Creation of infrastructure to study the role of animals in causation of corona infection since almost all the animals act as carriers of coronavirus

10. Establishment of more 'one health centres' with BSL-II facility (RT-PCR & ELISA) in each District, for screening both human and animal serum samples, along with the existing laboratories in 13 Districts of the state; Mass screening of animals for antigen-antibody in all possible animal population and their potential transmission
11. Studies on cross protection between corona virus in animals with COVID-19; Developing a recombinant protein based ELISA for seromonitoring of SARS cov-2 in pet animals
12. Customised financial packages for different kinds of farming activities of crops, horticulture, animal husbandry including dairy, poultry, piggery, goatery, etc., fisheries, sericulture, agroforestry and related enterprises
13. Due considerations by financial institutions, both banks and insurance companies, for innovative financing and timely support to farmers for production, processing and marketing activities
14. Ensuring protected price for agricultural produce as per the Ordinance on Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services, 2020

3. Industry

Karnataka has over 6.5 lakh industries with one crore employees as also 12 lakh traders and the impact of the pandemic on industry including MSMEs has been high. While there are several governmental schemes as also local interventions by the entrepreneurs to mitigate the situation, both the supply and demand chains are to be addressed by the industry and financial institutions.

1. Promotion of Micro Venture Capital Innovative fund; Exemption from electricity & water fixed costs during April-September, 2020; Provision of Financial aid equivalent to debt during April-September, 2020 and relaxation in taxes and contributions
2. Reintroduction of *Karmasamadhana* Scheme, with 100% waiver of interest and penalty, enabling yield revenue to the government as well as relief to concerned tax payers
3. Provision of a special COVID-19 Insurance scheme to cover health care of all personnel in Industry and Service sector, including Healthcare, Hospitality, Travel & Tourism sector; 50% waiver of interstate toll & entry fees to all tourist attraction sites across the country
4. Group Insurance for employees for the current year enabling workers to come back to work; Review of credit facilities in *Mudra* scheme and credit guarantee for providing working capitals
5. Food processing units to be given priority for credit under *Atmanirbhar* scheme; SHG Units' production to be given priority under public procurement system

6. Profiling and matchmaking of skills of immigrants and migrants with local industry needs; Educational institutions to be repurposed as Entrepreneurship Development Institutions

4. Labour

Labour, being the key input for an enterprise, witnessed the kind of migration never seen before in the country and the State in the background of the present pandemic. Along with health concerns, social and economic aspects also contributed to the large scale movement of people from cities to villages. The contribution of construction activity to State's income and employment is of the order of 5.5%, that also has an immediate employment potential. Along with the wage structure, several issues of gender, child marriage, food security and stigma associated with people who are assisting the patients were discussed.

1. Compulsory registration of all workers/migrant labourers as per the Act and MGNREGA workers under *Unnati* to build their skills for sustainable livelihood (NRLM)
2. Group Insurance to be provided for Employees by Government for the current year, for enabling the workers to come back and work; Wage incentivisation
3. Enhancing purchasing power in the hands of people to revive the economy; Strengthening MGNREGA by increasing number of days of employment provided and/or increasing the minimum wages offered for creating infrastructure of PHCs, schools and agriculture, etc.
4. Improving urban commons with low cost housing & better sanitation; Skilling and employing urban youth to work in day care centres for children at subsidized rates, for helping women to re-enter the labour force
5. Strengthening local governance, Gram panchayats and delivery systems; Providing for women and girls who are vulnerable, in terms of school drops, child marriage and domestic violence; Empowering ASHA and *Anganwadi* workers for suitable guidance and assistance
6. Investment in sex-disaggregated data collection; Decentralised means of public health messaging and ensuring access to benefits and treatment
7. Addressing Income and job losses with non-farm incomes; Encouraging rural industries for providing for migrants, eg. Plumbers and drivers returning to villages; Sensitising Panchayati Raj institutions
8. Fast tracking of projects under Special concession to private sector; Innovative job generation on lines of emerging activities in the pandemic
9. Enhanced public investment in employment generation projects in different sectors for demand revival

5. Skills

Knowledge and Skills have become the key ingredients for planning, particularly at moments like the COVID-19 pandemic. Several non-traditional activities are also emerging, that could be formalised and scaled up for remunerative entrepreneurship. As several delegates stated, Educational Institutions must now be repurposed for Entrepreneurship development.

1. Skill deficiency mapping in the State at all levels; Identification of institutions and resources for skill development; Recognition of Prior Learning (RPL) programmes to be reinvigorated for local youth
2. YES *Kendras* to mobilize youth for skill training programmes and coordinate with district-level industries for assessing demand requirements and matchmaking process
3. 20% of the PF amount of the employer to go into a Re-skilling fund for training & skilling and on retrenchment, for transitions and market failure in skill financing; Re-skilling fund to be linked to *Aadhar*; Employment exchange registration and Apprenticeship schemes to increase its effectiveness
4. Online labour exchange and Match making platform for demand and supply of labour
5. Establishment of Digital training centres where subject-matter experts can train youth to make them industry-ready by leveraging advanced technology platforms and solutions; All schools and colleges, ITIs, KVKs to be utilized for skilling at suitable times

6. Education

Societal impact of the COVID-19 is most visible in the Education sector, whether primary, secondary or higher education. Coming at the time of Examinations in the academic calendar, governments as well as the teacher-student fraternity have been discussing measures to address the consequences. While attempting new methods, as for example, online education, several issues such as Urban-Rural divide in Education, Public vs. Private educational institutions, etc. have emerged. These call for expert opinions, discussions by Education Institutions, Councils, Academies and Staff Colleges as well as feedbacks from the stakeholders, i.e. the students and the guardians.

1. Institution-specific Risk management teams for the planning process and implementation of the strategies the TALP (Technology-Aided Learning Programme); Training of teachers to adopt the theory of multiple intelligence, especially in reaching out to students with learning disabilities as also to PWDs; Gender-based Inclusiveness
2. For holding on-line classes, issues related to non-availability of smart phones, access to internet in poor households in rural areas and ease teaching and learning processes, for both the teachers as well as children, need to be addressed
3. Opinion surveys among all categories of schools with different stakeholders including parents could be sought regarding when to re-open schools for nursery and primary classes, higher primary classes and high school classes
4. Bridging the urban-rural gap in Education, approaching the internet service providers in rural areas on PPP model; Options for holding classes through dedicated radio/TV channels, with inputs from The National Institute of open schooling (NIOS)
5. Addressing the resources and facilities available in public institutions, both in secondary and higher education; Developing SOPs for student internship with the industry, as part of the course requirements; Vocational training classes in evening shifts with limited durations

6. Online Teaching and Learning arrangements under *Atmanirbhar* scheme; Rental schemes/Special loans for poor students to acquire digital tools
7. Possible substitution of Practical classes with 3D-Animation and other virtual learning methodologies to be designed through start ups; Developing good quality reading material in regional languages for multi-linguistic issues in disciplines like Languages, Humanities and Social Sciences,
8. Formulating SOPs for conduct of online Examinations, with inputs from Karnataka Examination Authority; Public and Stakeholder consultations
9. Digital Skilling of teaching faculty to be made mandatory; Higher Education Academy at Dharwad may design suitable training modules and organise training programmes for the teaching faculty
10. Career Guidance calls to be created online (UNDP model); Industry-Higher Education skill match based curriculum to be redesigned
11. Databases need to be developed and utilised for decision support; Provision of working capitals for relevant start ups; Challenges of MSMEs to be addressed
12. Repurposing educational institutions for entrepreneurship; Teachers laid-off by colleges, especially engineering, to be equipped to start their own enterprises; Academia-Industry coordination for generation of employment opportunities for graduates
13. Emergence of a new post- COVID-19 academic culture, in all dimensions of education, including hygiene and sanitation in class rooms, laboratories, workshops, washrooms; Social distancing and use of masks; Conduct of classes and examinations, that need to be provided with SOPs and guidelines
14. Formulation of Education-level specific strategic plans for different levels; Aggressive capacity building for the teachers; Risk assessment and management measures
15. Suitable financial incentives for both deserving students and educational institutions under RTE, RUSA and other schemes, to maintain the academic vigour in the State; Addressing school drop outs in the context of the pandemic

7. Science & Technology

S&T interventions have played a key role in detecting and managing the COVID-19 pandemic all over the world. The required inputs have also been coming from Indian Institutions as well as in the State, with regard to planning economic activities. While further R&D efforts are underway, relevant questions, hypotheses and suggestions are aiding the programmes being undertaken by the governments.

1. Focus to shift from translational research to basic and interdisciplinary research in the context of COVID-19 vaccine; Funding agencies must be forthcoming to fund relevant basic research in animal sciences (Microbiology, Epidemiology, Virology, Cell Biology, Genetics, etc.)
2. Integrated research with the involvement of local, national and international collaboration; Meaningful research collaborations between renowned

researchers working on basic science projects and those working in applied research organizations/industries

3. Individual immunity and Citizen immunity checks and comparisons between countries; GIS based analysis for pandemic management
4. Developing a Data Registry for all vulnerable groups, particularly for the labourers and workers, for a proper strategy; Adoption of GIS to generate holistic data base through integration of both numerical and spatial data
5. Production of efficient, cost-effective and reusable masks; Holistic Healthcare along with relevant R&D including Ayurveda for better community immunity
6. Educational institutions and Universities to be involved in creation of awareness, along with S&T institutions for general public; Customised, user-friendly technologies for online education
7. Daily authentic information on the status of COVID-19 through Media; Use of Telehealth and Telemedicine for treatment in remote areas; Integration of core virus aspects and consequent social issues

8. Public Affairs

Along with the Healthcare system, public agencies of police and municipalities have been playing a key role in managing the COVID-19 pandemic. They are revisiting the plans on a continuous basis, using all possible resources and technologies. Here again, there is a great deal of learning happening, resulting in new models across the country and the State.

1. Assessment of vulnerability and synergy in planning and implementation across agencies; Disaster risk reduction to be incorporated in planning; Dense urban pockets being the cause of community spread, need to be spaced and provided with additional housing
2. Police staff to use drones in greater measures to monitor social distancing and masks in crowded places (under Sec. 188 IPC); Empowering community volunteers to help in enforcing the SOPs; Protecting police personnel & their families with adequate supply of PPEs, masks, sanitizers & AYUSH remedies and medical check ups
3. Enrolling more people under Home Guards category; Mobilizing NCC/NSS cadres to help in regulations during Unlock period; Ensuring maintenance of peace, law & order by gathering quick intelligence on brewing social discontent, if any, through community action plans
4. Provision of pollution free mobile incinerators to handle garbage/dead bodies; Additional space for burial of dead bodies; Aggressive on line community awareness for handling Corona waste through RWAs and community volunteers
5. Using SECC data base to ensure coverage of all deprived category households for socio-economic relief measures like pensions, MGNREGA job cards, skilling, housing, etc.; Provision of ration cards to deprived categories not having PDS facility; Digital literacy and Financial inclusion through Banks; Postponement of EMI & Loan repayment
6. Building shelters along highways for migrants during disasters; Food customization; Panchayat level disaster management plans as per Disaster Management Act, 2005

9. Policy

The foregoing account in terms of interventions in different sectors leads to policy formulation, as a reference to the changes required in the face of the present pandemic. They encompass health, nutrition, food security, economy, institutions, all for ensuring both individual and the community well being.

1. Domiciliary treatment public guideline as a COVID-19 strategy; Ensuring resilient food and health systems; Preventive and Integrated Immunity boosting strategy
2. Monitoring of toxicity of food systems, zoonoses and cross-over of diseases among animals, humans and wildlife
3. Economic considerations and policy design with emphasis on devolution and Panchayat Raj; Developing system models with multiple scenarios in totality
4. Recognising Innovative financial investment models including Micro venture capital; Addressing Industry problems with District clusters as catalysts; Public-Private Partnerships in online shopping, that is expanding rapidly in the present context
5. Ease of lending loan to industry, especially MSMEs; Implementation of all business reforms to promote Ease of doing business
6. Clarity in approach to the current economic situation by the Corporates; Industry bodies to come up with a corpus fund, to aid enterprises in distress, eg. Cinema halls, marriage halls, etc.

10. Partnerships

Foresight, Innovation and Partnerships are key drivers of an economy, particularly in the current context. Several linkages and partnerships are already emerging between different sectors in the form of new ventures and practices. They would become the new normal and good practices in times to come. This is an opportune time for analysing the strengths and benefits of partnerships to overcome the problems and establish the new order.

1. Establishing an Innovation platform for COVID-19, with leading research and educational institutions (eg. Indonesia); Young Data Scientists' Group
2. Forming linkages with international agencies such as The World Bank, ADB, BMGF, for relevant COVID-19 mitigation efforts; Partnership with UNDP for a Help line for assistance to MSMEs and skill development of youth in association with Chambers of Commerce and Industries and other Associations
3. Formation of 'Share & Care' Groups, with Doctors and Philanthropists, in different towns; Citizen Budget Tracker and CSR platforms for financing COVID-19 activities
4. Networking and stronger collaboration between Karnataka Government Agencies and NGOs working on the pandemic

VI. Way forward

The Meeting on 'COVID-19: Strategy and Way Forward for Karnataka', with experts and delegates from different sectors of economy provided an opportunity to learn from each other as also appreciate the status of the pandemic in the State vis-à-vis the globe and the country. The subject being universal, new to science and society, at the same time complex, received multi-sectoral views with regard to understanding and addressing the problem. Impact and Risk assessment with regard to different economic activities came out clearly, as a base for

further planning. Suggestions and views for mitigation provided an insight into the experiences and requirements, at the same time, preparedness to face a likely prolonged situation in Karnataka.

Innovation, customisation, adaptation to emerging scenarios and situations would be the way forward, with strong partnerships to complement efforts at rebuilding the losses. New ways of transactions and communications have also emerged, that could lead to new Good Management Practices, that need to be documented and incorporated in our lives. As a knowledge society, the State of Karnataka would provide a model, deploying all the available S&T tools for addressing the pandemic, at the same time, adding new information in the process.

VII. Literature Cited & Further Reading

1. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020.
<https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19-11-march-2020>
2. Doshis, P., 2020. The elusive definition of pandemic influenza, *WHO Bulletin* 2011; 89: 532-538.
3. Deo, M.G., 2020. Host factors in swine flu pandemic in India. *Indian J Med Res.*, 2009; 130: 772-773.
4. Deo, M. G., 2020. Corona control in India - The Facts. *Note of the NSAI*, Allahabad, 6 pp.
5. Kaplan j, Frias L, McFall-Johnsen M A Third Of The Global Population Is On Coronavirus Lockdown, 2020.
<https://www.businessinsider.in/international/news/a-third-of-the-global-population-is-on-coronavirus-lockdown-x2014-hereaposs-our-constantly-updated-list-of-countries-and-restrictions/slidelist/75208623.cms>
6. Lipsitch, M., D. L. Swerdlow and L. Finelli, 2020. Defining the Epidemiology of Covid-19: Studies Needed. *New Engl. J. Med.*, 382:1194-1196.
7. Munster, V.J., M. Koopmans, N. van Doremalen, D. van Riel and E. de Wit, 2020. A Novel Coronavirus Emerging in China - Key Questions for Impact Assessment, *New Engl. J. Med.*, 382: 692-694.
8. Lavezzo, Enrico, *et al.*, 2020. Suppression of a SARS-CoV-2 outbreak in the Italian municipality of Vo'. *Nature*: 1-1.
9. Prem, K., Y. Liu, T. W. Russell, A. J. Kucharski, R. M Eggo, and N. Davies, 2020. The effect of control strategies to reduce social mixing on outcomes of the COVID-19 epidemic in Wuhan, China: a modelling study, *Lancet*, 20: 2468-2667.
10. Cohen, J. and K. Kupferschmidt, 2020. Countries test tactics in 'war' against COVID-19. *Science*, 367 (6484): 1287-1288.
11. Walker, P. G. T. *et al.*, 2020. The Global Impact of COVID-19 and Strategies for Mitigation and Suppression, Preprint at Spiral <https://go.nature.com/2yqz47x>.

12. Flaxman, S. *et al.*, 2020. Report 13: Estimating the number of infections and the impact of non-pharmaceutical interventions on COVID-19 in 11 European countries, Preprint at Spiral <https://doi.org/10.25561/77731>.
13. Wu, P., X. Hao, E. H. Y. Lau, J. Y. Wong, K. S. M. Leung, J. T. Wu, B. J. Cowling, and G. M. Leung, 2020. Real-time tentative assessment of the epidemiological characteristics of novel coronavirus infections in Wuhan, China, as at 22 January 2020. *Euro Surveill.*, 25, 2000044. i:10.2807/1560-917.ES.2020.25.3.2000044.
14. Ferguson, N.M. *et al.*, 2020. Impact of non-pharmaceutical interventions (npis) to reduce covid-19 mortality and healthcare demand. London: Imperial College COVID19 Response Team, March 16, 2020, 10.25561/77482.
15. Li, Q., X. H. Guan, P. Wu, X. Y. Wang *et al.*, 2020. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia, *New Engl. J. Med.*, <https://www.nejm.org/doi/10.1056/NEJMoa2001316>.
16. Roy M Anderson, Hans Heesterbeek, Don Klinkenberg and T Déirdre Hollingsworth, 2020. How will country-based mitigation measures influence the course of the COVID-19 epidemic? *Lancet*, 395: 931-934.
17. X. He, E. H. Y. Lau, P. Wu, *et al.*, 2020. Temporal dynamics in viral shedding and transmissibility of COVID-19, *Nature Medicine*, 26: 672–675.
18. Prakash, Meher K., 2020. Quantitative COVID-19 infectiousness estimate correlating with viral shedding and culturability suggests 68% pre-symptomatic transmissions. *medRxiv*.
19. Prakash, Meher K. *et al.*, 2020. A minimal and adaptive prediction strategy for critical resource planning in a pandemic. *medRxiv*.
20. Tuli, S., S.Tuli, R. Tuli and S.S.Gill, 2020. Predicting the growth and trend of COVID-19 pandemic using machine learning and cloud marketing. *Internet of Things*, 13 pp.
21. Padmanabhan, Govindarajan and Arun Nagaraj Viswanathan, 2020. Hydroxychloroquine: A relatively obscure antimalarial takes centre stage in COVID-19. *Curr. Sci.*, 118(10): 1489-1491.
22. United Nations 2020. A UN Framework for the immediate Socio-Economic response to COVID-19. <https://unsdg.un.org/sites/default/files/2020-04/UN-framework-for-the-immediate-socio-economic-response-to-COVID-19.pdf>
23. The World Bank, 2020. Global Economic Prospects, June 2020. Washington, DC: World Bank. DOI: 10.1596/978-1-4648-1553-9. License: Creative Commons Attribution CC BY 3.0 IGO.
24. UNIDO, 2020. The economic impact of COVID-19 pandemic._ <http://www.unido.or.jp/en/news/6801>
25. World Economic Forum, 2020. The Impact of COVID-19 on the Future of Advanced Manufacturing and Production Insights from the World Economic Forum's Global Network of Advanced Manufacturing Hubs._ http://www3.weforum.org/docs/WEF_AMHUB_Insight_Paper_2020.pdf June 2020

26. FAO, 2020. Coronavirus disease 2019 (COVID-19) | Addressing the impacts of COVID-19 in food crises (April–December 2020) – May update. Rome. (http://www.fao.org/fileadmin/user_upload/emergencies/docs/COVID-19%20Appeal%20%E2%80%93%20MAY%20update%202020.pdf)
27. UNESCO, 2020. Culture and COVID-19: Impact & Response Tracker. https://en.unesco.org/sites/default/files/special_issue_en_culture_covid-19_tracker.pdf
28. Kaushal, Shaurya, *et al.*, 2020. Estimating Hidden Asymptomatics, Herd Immunity Threshold and Lockdown Effects using a COVID-19 Specific Model. *arXiv preprint arXiv:2006.00045*.
29. Kant Amitabh, Mothkoo Venugopal and Sinha Siddharth, 2020. COVID-19: Trends in India and the World: <https://niti.gov.in/sites/default/files/2020-04/COVID-19-Trends-in-India-and-the-World.pdf>
30. Saidapur, S.K., 2020. Trends in the 21st Century Education. *University News*, 58(18): 3-9.

VIII. Annexures I -V

- I Programme of the Meeting on 'COVID-19: Strategy and Way Forward for Karnataka', Bengaluru; 19 June, 2020
- II List of Participants
- III Post COVID-19 Strategy: Dr C.N. Manjunath, Director, Sri Jayadeva Institute of Cardiovascular Sciences & Research, Bengaluru
- IV White Paper on COVID-19: Dr Aloke Kumar, IISC; Dr Santosh Ansumali, JNCASR & Dr Meher Prakash, JNCASR; Bengaluru
- V 'An Open Letter to the UN, G-20, and National Governments on COVID-19 and Agriculture for Food and Nutrition Security on 26 May, 2020'

**Planning, Programme Monitoring & Statistics Department
Government of Karnataka
&
Karnataka Science and Technology Academy
(Department of Science & Technology, Govt. of Karnataka)**

**Meeting on 'COVID-19: Strategy and Way Forward for Karnataka'
Bengaluru; 19 June, 2020**

Programme (11 AM to 4 PM)

1. Introduction of Participants
& Welcome Address: Prof. S. Ayyappan, Chairman, KSTA
2. Inaugural Address: Shri B.J. Puttaswamy, Vice Chairman, State
Planning Board, Government of Karnataka
3. Address: Dr (Smt.) Shalini Rajneesh, Addl. Chief Secretary,
GoK, Planning, Programme Monitoring & Statistics
Department
4. Address: Dr E. V. Ramana Reddy, Addl. Chief Secretary, GoK
Higher Education, Electronics, IT, BT, S&T Departments
5. Presentations:
 - (i) Dr C.N. Manjunath, Director, Sri Jayadeva
Institute of Cardiovascular Sciences &
Research, Bengaluru
 - (ii) Dr Akash Prabhune, Consultant (Health), Centre for
Public Affairs, Bengaluru
 - (iii) Dr Aloke Kumar, IISC; Dr Santosh Ansumali, JNCASR,
Dr Meher Prakash, JNCASR; Bengaluru
 - (iv) Dr Chaya K. Degaonkar, Addl. Chief Evaluation Officer,
KEA, PPMSD, GoK
6. Remarks by Delegates and EC Members, KSTA
7. Discussions and Finalisation of Strategy Paper
8. Vote of thanks: Dr A.M. Ramesh, CEO, KSTA

List of Participants

Sl. No.	Name	Email ID
	Inaugural Session	
1	Shri B. J. Puttaswamy, Hon'ble Vice Chairman, State Planning Board, Govt. of Karnataka, Bengaluru	kstateplanningboard@gmail.com
2	Dr (Smt.) Shalini Rajneesh, IAS, ACS, GoK, Planning, Programme Monitoring & Statistics Department	acsplanningkar@gmail.com
3	Dr E. V. Ramana Reddy, IAS, ACS, GoK, Higher Education, Electronics, IT, BT, S&T Departments	itbtsec@karnataka.gov.in
	Presentations	
4	Dr C. N. Manjunath, Director, Sri Jayadeva Institute of Cardiovascular Sciences & Research, Bengaluru	drcnmanjunath@gmail.com
5	Dr Akash Prabhune, Consultant (Health), Centre for Public Affairs, Bengaluru	akashprabhune@pacindia.org
6	Dr Aloke Kumar, Dr Santosh Ansumali & Dr Praksh Meher, Faculty at IISc & JNCASR, Bengaluru	alokekumar@iisc.ac.in ; ansumali@gmail.com ; meher@jncasr.ac.in
7	Dr (Smt.) Chaya K. Degaonkar, Addl. CEO, KEA, PPMDS, GoK	chayakd@gmail.com
	<u>Delegates</u>	
	Health	
8	Dr Alex Thomas, President, NBAI	alexthomas.ahpl@gmail.com
9	Dr Arvind, Health Expert	arvindk@gmail.com
10	Dr B. S. Prasad, Health Expert	dr_bsprasad@rediffmail.com
	Public Institutions (Economy & Policy)	
11	Sri C.R. Janardhan, President, FKCCI, Bengaluru	president@fkcci.in cr.janardhana@gmail.com
12	Dr (Ms) Hema Swaminathan, Professor, Centre for Public Policy, IIM, Bengaluru	hema.swaminathan@iimb.ac.in
13	Dr (Ms) Jyotsna Jha, Head, Centre for Budget and Policy, Bengaluru	director@cbps.in
14	Dr Kishor Jagirdar, Board Member, Vision Karnataka Foundation, Bengaluru	kishor.Jagirdar@vkfoundations.org
15	Dr (Ms) Smita Srinivas, Professor, NIT, Bengaluru	srinivas@alum.nit.edu

	Agriculture & Veterinary Sciences	
16	Dr R. N. Srinivasa Gowda, Former Vice Chancellor, KVAFSU, Bidar	drnsgowda@gmail.com
17	Dr K. Narayana Gowda, Former Vice Chancellor, UAS, Bengaluru	knarayanagowda@yahoo.co.in
18	Dr S. Rajendra Prasad, Vice Chancellor, UAS (B), Bengaluru	srprasad1989@yahoo.co.in vcuasb1964@gmail.com
	Disaster Management	
19	Dr C.N. Prabhu, Scientific Officer, KSNDMC, Bengaluru	ncdms2018@gmail.com redyvs@yahoo.com
	Education	
20	Dr Jai Asundi, Executive Director, CSTEP, Bengaluru	cpe@cstep.in
21	Dr K. V. Subramanian, Consultant, Higher Education	drkv.subramanian@gmail.com ksche.bangalore@gmail.com
	S&T Interventions	
22	Dr H. Honne Gowda, Former Special Secretary, DST, GoK, Bengaluru	honnegowda.h@ka.gov.in hkg.ksteps1@gmail.com
23	Dr K. Mukund Rao, Chief Executive, C-SAG, NIAS, Bengaluru	mukund@csag.res.in
24	Dr S.G.S. Swamy, Consultant, VGST, DST, GoK, Bengaluru	swamysgs@gmail.com
	KEA	
25	Dr Manjunath, Director, KEA, GoK	manjublore@gmail.com
	KSTA EC Members & Special Invitees	
26	Prof H. A. Ranganath, Former Vice Chancellor, Bangalore University & Director, NAAC, Bengaluru	haranganath@gmail.com
27	Prof. B.G. Mulimani, Former Vice Chancellor, Gulbarga University	bgmulimani70@gmail.com
28	Prof. A. H. Rajasab, Former Vice Chancellor, Tumkur University	rajasab55@gmail.com
29	Prof. Katre Shakuntala, Former Dean (Science) & Head, Dept. of Zoology, Bangalore University, Bengaluru	skatre1946@gmail.com
30	Shri Nagesh Hegde, Eminent Science Writer, Bengaluru	Nagesh.hegde@gmail.com
	KSTA Secretariat	
31	Dr A. M. Ramesh, CEO	ramesh.aquatic@gmail.com
32	Dr Anand, R, SSO	kanchananand@yahoo.com
33	Sri Umesh V. G. SO	vgumesh.ksta@gmail.com
34	Sri V. K. Srinivasu, SO	vksri03@gmail.com

Post COVID-19 Strategy

Dr C.N. Manjunath
Director

Sri Jayadeva Institute of Cardiovascular Sciences & Research, Bengaluru

The unprecedented COVID-19 Pandemic has resulted in medical emergency across the globe, affecting a large number of people causing high morbidity and also mortality resulting in paralysis of all walks of life. To curtail the menace of spreading this virus, Government of India as well as the State Government have taken several precautionary measures such as Lockdown, Containment Zones, Sealing down high risk zones, apart from advising other measures such as Social Distancing, Wearing of mask, Thermal scan and hand hygiene, etc. The whole objective of the Lockdown is not only to prevent the spreading of virus, but also for preparedness with respect to health, infrastructure, manpower and mobilization of resources and also to understand the natural history of this disease. It is equally important to plan between life and livelihood, with the initial emphasis given to safety of the countrymen in the form of Lockdown for nearly 77 days.

The natural history of this COVID-19 infection is like any other previous illness such as SARS, MERS and Spanish Flu. For the last for 5-6 months, we in India, are in fourth month, so definitely it is likely to pull over into July and early August. It looks there is a surge of cases for which preparedness is extremely important. If required, temporary arrangements should be made in Exhibition halls, Stadiums and school grounds using removable structures. It is also important to ramp up testing, so that many asymptomatic carriers can be identified and this random testing is to be undertaken among highly exposed sub-groups such as: BMTC/KSRTC Staff, Police Personnel, Health Care Workers, ASHA workers, Anganawadi workers, Railway Station Staff, Pura-karmikas, Slum dwellers, Delivery/Sales boys, Market areas, Civil Court Zone, Autorickshaw Drivers, Foot path Vendors, as also one more round of test in earlier containment zones.

Initially, there was less rise of cases but unfortunately, India is surging with respect to cases and mortality, which is a matter of great concern. Government of Karnataka headed by Hon'ble Chief Minister and supported by the Health Minister, Medical Education Minister, bueraucracy and all connected departments have done a tremendous job in controlling and containing this pandemic. However, nature is always ahead of technology and our efforts, but still the achievements by the State Government is commendable. It is only next to Kerala, Karnataka has done well in the entire country. Up to April, 2020, there were only 8-10 laboratories for COVID testing, that are now 75 and Karnataka has already conducted more than 4.5 lakhs tests, with an average of 8,000-12,000 per day. The 4-T Mantra of 'Tracking, Tracing, Testing & Treating' has worked well so far. The Health Department also formed various Task Forces to take the stock of situation which is dynamic and evolving so that health and hospital issues, quarantine isolation, etc. were addressed.

Various innovative methods were adopted using technology such as on line training of Doctors and Health care workers for COVID-19 management, remote thermal scans, tele-

consultations and remote ICU management. Quarantine watches have been tracking the movement of positive cases and testing KIOSKS within fever clinics and mobile lab testings played a significant role in early diagnosis and quarantining and Isolating. The Karnataka Government has aggressively implemented the lockdown as well as containment area seal down. Even during partial relaxation of lockdown, as there is a high risk in the containment zone, they were sealed off.

The preparedness of both the Teaching hospitals as well as District Hospitals was reinforced by adding Ventilators and supplying medical gadgets including high flow oxygen systems and adequate supply of PPEs, N95 masks, Sanitizers round the clock. The darker side of the lockdown is the closure of business establishments, hotels, restaurants, Industries, both small and medium scale, religious places, schools and colleges, factories, IT-BT and so on, which has resulted in loss of jobs, loss of lives, deduction in the salaries, etc. Another heart touching issue during the lock down period is the struggle of the migrant workers to reach their native places from work places. They are left with empty bags and hunger and all infrastructure projects, constructions, etc. have come to stand still. The farmers were not able to sell their produce and many have destroyed their crops resulting in huge financial burden. All these call for a collective, comprehensive and collaborative action plan to support and stimulate various sectors, particularly the labour class.

The role of banking sector is extremely important to see how best they can support all the sectors which have suffered, most in terms of relief or defer payments of EMLs including waiving of interests. Several people would have taken loans for various properties and both agriculture and non agriculture sector are not in a position to pay the EMLs which is a matter of concern, since there is no production or business turn over in all the sectors. With GDP dropping and inflation going up, there is a need to infuse confidence to the public and promote travel and tourism which creates some jobs. Another important thing that needs to be addressed is to bring back the migrant labourers so that all concerned connected sectors can resume normal activities once there is flattening of the COVID 19 curbs.

The schools and colleges have been closed for a long time and it is unlikely that they would open before August, 2020. Students as well as parents are under stress and a policy has to be evolved to conduct on line teaching including on line examinations. The Government however has already suggested it cannot be applied to those children below 10-11 years of age group. On line education has some disadvantages such as screen addiction which is one of main cause for the mental disorders. The work from home policy practice, particularly in IT-BT sector, used as an attractive healthier option, also has some health hazards. Health care professionals and other workers including ASHA and *Anganawadi* workers, Police and other field workers are providing selfless services risking their lives. Hence, a comprehensive action plan is required to both save lives and promote livelihoods.

Resource mobilization and revenue generation is also a priority. Farmers and labourers are the backbone of the country and need special attention. The governments can fight Corona only with the active support and cooperation from the public. The need of the hour is to provide Cash transfers to these sectors to tide over this period.

White Paper on COVID-19

**Dr Alope Kumar, IISC; Dr Santosh Ansumali, JNCASR & Dr Mehar Prakash, JNCASR;
Bengaluru**

1. Context

COVID-19 infections have breached the seven million mark worldwide, yet there is neither a vaccine nor a scalable treatment in sight. These challenges have driven governments to implement non-pharmaceutical interventions (NPIs) such as social distancing and partial or full lockdowns. An unsaid, *a posteriori*, rationale for these lockdowns is that they provide efficient isolation mechanism for asymptomatics, a unique characteristic of COVID-19 described below.

2. Unique aspects of COVID-19

A distinctive feature of the COVID-19, in contrast to other infectious diseases such as Influenza or SARS, is the presence of a large fraction of “asymptomatic” patients, who don’t have any obvious symptoms but are still capable of infecting susceptible individuals through contacts. Which means screening individuals by checking their temperature or symptoms serves the purpose only partly. Moreover, the chance of spread of infection and mortality rates for COVID-19 are very different than other epidemics.

3. Herd Immunity

When an infectious disease has already affected the significant fraction of the society, the rate at which new infections will be recorded will slowdown. For COVID-19, the total infection fraction is estimated to be between 50-60% for this herd immunity. However, there are estimates that the asymptomatic infections in COVID-19, which are usually missed out in the reported infections, are around 10x of the symptomatic infections. Under this current knowledge, a herd immunity may be achieved when reported infections reach around 5-6% of population, which may be around 38 Lakh infections.

4. Learning to live with SARS-Cov-2

Since the herd-immunity is far from the current infections, vaccine is not around, it is important to appreciate the unique features of COVID-19, which still remain unaltered despite summer temperatures and some mutations, continue to pose the challenge. The first wave of infections was contained during the lockdowns in Karnataka. Looking forward the scenarios that may arise are:

- Scenario 1. A second wave of acute level of infections which may require an active and harsh Government intervention
- Scenario 2. A sustained level of infections that must be managed by having the responsibility shared by individuals and organizations

5. Scenario I: Second Wave of Infections

Detecting this scenario. A second wave of infections may be defined as a phase, hopefully hypothetical, where the infections will continue to grow exponentially. If and when a second phase arrives the effects of the first wave of lockdown may not be apparent, the

infections may grow all over again, requiring forecasts of infections, overload of hospital facilities, etc. To prepare for this second phase, one will require two types of modelling efforts which will make these predictions.

Long-term models

Successful long-term models need to be able to capture not only the entire disease dynamics, but also account for policy interventions such as lockdowns. In the image below, we show how the rate of infections changed under lockdown. Before lock-down, the data points for Karnataka seemed to follow an exponential trajectory. Post-lock-down this transitioned to an almost flat profile, which showcases the success of the lockdown. However, as the lockdown is being lifted the curve has now transitioning again to an exponential curve. This suggests that a very aggressive contact-tracing and quarantining are required right now in order to contain the situation. Our group has created a model, which successfully captures the effects of lock-down and can be used for quantitative evaluations.

Short-term models

The much discussed peak of infections, or predictions for many months depend on at least two factors –

- the virus and changes in it,
- how people interact with each other and thus how easily it is transmitted

The behavioral dynamics of the society may be variable with time. In the second wave people may use higher level of personal protection, and the alertness of people may change as they hear more about infections. Thus, one may have to consider models which adapt according to the society's response to the infections. This class of models are the short-term adaptive models.

In the above figure, in the left hand side is shown a heuristic adaptive model which can be used for prediction of disease trajectory from time-series analysis of data. Such projections can provide reliable estimates for time-horizons of 2-6 weeks and can be used for calculating critical requirements such as medical inventory. In the right, we show a snapshot of our medical inventory projection platform, which can be accessed at <https://covid19medinventory.in>

Policy measures

In case of a second wave of infections, with exponential growth once again, unfortunately one may have to implement similar policies as were implemented in the first wave, the merits of each of which may be evaluated in a context-dependent way as the need arises:

- Strict enforcement of containment zones
- District-wise lockdown implementation (DLIs) – Implement lockdowns in districts where infections are rising beyond control to bring the situation under control
- Travel bans (TBs) – Travel bans from outside state regions which have exceedingly high infection rates
- Testing of people at railway station and airports- A perhaps less restrictive but more effective mode would be to test every person coming to Karnataka from outside. This might allow a balance between opening the economy and keeping the safety of people. A model to be followed is Hongkong in this regard (<https://fortune.com/2020/04/08/coronavirus-testing-hong-kongairport/>)

- Very Short-term Lockdown Implementation (VSLI) – Implement lockdown on selective days of the week such as every Wednesday or for Wednesday and Thursday and make Saturday a full working day.

6. Scenario II: Sustained Low Level of Infections with no exponential growth

Detecting this scenario. When this scenario arises, one has to identify the sources of infections and characterize these infections. This phase can only be managed with detailed information on the infections, not with a total number of infections. To plan for this, the Government has to collect the following data from the individuals who are reported to be infectious and share the same, some of which may be sensitive, with the relevant modeling teams to facilitate data-analytics:

- Age, of the infected, is it infecting people of certain age groups
- Information on whether other people from the same household, neighborhood or workplace reported infections earlier. This may be reported by the patient or inferred through analytics
- The residential buildings, or work places where these infections are occurring
- Nature of profession or residential setting, or transport modes used by these individuals
- Gatherings or activities the individuals participate in: religious gatherings, recreational activities, conferences or meetings they attend, etc.

Mitigation Steps through Policy

- Establishing contact tracing protocols: centralized individual centric or de-centralized institutional centric (tracking people that enter an office, restaurant, or a cinema) rather than constantly tracking them
- If a certain vocation is posing higher risk than others, design plans for working in shifts
- Advising firms to encourage work from home for people with senior citizen at home.
- Imposing limits on gathering sizes
- Limiting the number of people per public transport option
- Other creative policy frame-works should be investigated

7. Adaptive Problem requires Adaptive Solution

The infection rate depends on both the virus and how people move around. The implementation at the ground-level, for example of a lockdown, may be very different from what is envisioned. The success of implementation of the strategies ultimately is indicated by the numbers of infections, within a few weeks of the strategy. Any policy decision should be continuously monitored and revised. For example, one event that violates congregation norms can suddenly become a new epicenter for hundreds of infections, which in a few days can multiply beyond count. One has to be constantly vigilant, to the developments, formulate strategies, and track their implementation on the ground-level.

8. References

1. Prakash, M.K., Kaushal, S., Bhattacharya, S., Chandran, A., Kumar, A. and Ansumali, S., 2020. A minimal and adaptive prediction strategy for critical resource planning in a pandemic. *medRxiv*.
2. Kaushal, S., Rajput, A.S., Bhattacharya, S., Vidyasagar, M., Kumar, A., Prakash, M.K., Ansumali, S., 2020. Estimating Hidden Asymptomatics, Herd Immunity Threshold and Lockdown Effects using a COVID-19 Specific Model. *arXiv*.

3. Prakash, M.K., 2020. Eat, Pray, Work: A meta-analysis of COVID-19 Transmission Risk in Common Activities of Work and Leisure. *medRxiv*.
4. Ansumali, S. and Prakash, M.K., 2020. A Very Flat Peak: Why Standard SEIR Models Miss the Plateau of COVID-19 Infections and How it can be Corrected. *medRxiv*.

Introduction to COVID epidemiology

Background

The World Health Organization has declared COVID-19 as a pandemic, the first one in the 21st century [1]. Several attempts to develop therapeutics and vaccines are underway [2-4]. Yet, none of them have shown a promise. There are already 12 million infections and over 550,000 deaths globally, and the number of infections continue to rise. As such, non-pharmaceutical interventions of various degrees – using masks, social distancing, and lockdowns have been the only way of containing the pandemic to date. While it is clear that large scale lockdowns will have adverse effects on the economy, yet that was the only option that helped reach a high degree of control over the spread of the infections.

Disease epidemiology

The epidemiological parameter R_0 (R-naught) signifies how many new infections are caused on average by an infected person. The R_0 of COVID-19, for which some of the estimates have been around 2.2 to 2.5, [5,6] is a regularly monitored parameter to see if the spread of the infection is contained. Going one step further into understanding the origins of R_0 , the spread of infections depends on the physical contact between the infected and the susceptible individuals, as well as on how long an infected person can infect others.

Detection

So far the only reliable way of diagnosing that someone is infected is by RT-PCR tests of samples collected through nasal swabs [7-10]. These tests are highly technical in nature, and it has not been easy to scale up the tests to a meaningful size of the population in any country.

Non-symptomatic infection spread

In COVID-19, a substantial amount of infections are transmitted through asymptomatic individuals [11], and their infectiousness profiles are harder to track. Estimates say that about 44% [12] to 68% [13] of the infections are spread by individuals who do not have any symptoms such as fever, coughing or sneezing. Which means that the thermal scans which are used to quickly screen and isolate infected individuals are highly inefficient.

Herd Immunity

If there are no effective pharmaceutical interventions, and lockdowns can have economic consequences, is waiting for herd immunity an option [14-15]? Herd immunity is when sufficient fraction of the population develops immunity, either due to infections or due to vaccines, the spread of new infections halts. However, estimates for COVID-19 show that about 50% of the population should be infected, including the symptomatic and asymptomatic ones. Even in the metropolitan cities that suffered the highest, the seroprevalence studies show that the total number of infections are still less than 20% [16, 17]. Thus waiting for herd immunity is not an option.

Predictions of the Peak

Because of the intensive care requirements for 10-20% of the infected [18] and high mortality rate (3-10%) [19], it is important to know how long the infections will persist and how to manage the spread of infections. A question that is usually asked is “is the worst over, or yet to come” or said differently when is the peak of the infections. To know how the infections will develop, one needs to resort to models, even if they have inherent limitations.

Models

All possible ways in which the pandemic can develop – availability or non-availability of therapeutics, spread of infections, herd immunity – are filled with uncertainties. As such, one needs an understanding of the situations may develop, so that one can recognize early signs of how the trajectory may be evolving and plan for it.

Some of the commonly used epidemiological models divide the population into three different groups the Susceptible-Infected-Recovered (SIR) and study the dynamics across them. Many lockdown programs were guided by such SIR models [20-21]. Governments and public health modelers are interested in understanding the effectiveness of various strategies [22-26] starting from a complete lockdown, or a reduced social contact and a subsequent release of restrictions in a phased manner.

Many of the early models for COVID-19 spread were guided by the previously known infections due to SARS-2003, influenza etc. However, as there is newer knowledge about the role of asymptomatics, newer models (SAIR) have been developed [27]. As more information becomes available, there is a need for even further adaptation of the models.

Adaptive Strategies

As months go by, several factors are likely to change – the spread of infections due to the change in virulence, weather, human behavioral patterns or possible availability of vaccines, the changes in mortality to due improved management or an overload of health care systems. Similarly, as policies, one must have adaptive strategies to deal with the pandemic before its peak, or to avoid a resurgence after its peak. These strategies have to be developed by constantly updating the models based on the available data.

References

1. "WHO Director-General's opening remarks at the media briefing on COVID-19—11 March 2020". World Health Organization.
2. Le, T. Thanh, et al. "The COVID-19 vaccine development landscape." *Nat Rev Drug Discov* 19.5 (2020): 305-306.
3. Lurie, Nicole, et al. "Developing Covid-19 vaccines at pandemic speed." *New England Journal of Medicine* 382.21 (2020): 1969-1973.
4. Liu, Cynthia, et al. "Research and development on therapeutic agents and vaccines for COVID-19 and related human coronavirus diseases." (2020): 315-331.
5. Li, Q. et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N. Engl. J. Med.* 382, 1199–1207 (2020).
6. Wu, J. T., Leung, K. & Leung, G. M. Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a modelling study. *Lancet* 395, 689–697 (2020)
7. Zou, L., Feng Ruan, Mingxing Huang, SARS-CoV-2 Viral Load in Upper Respiratory Specimens of Infected Patients, *N engl j med* 382;12 nejm.org March 19, 2020
8. Kim, J. Y., J.-H. Ko et al., Viral Load Kinetics of SARS-CoV-2 Infection in First Two Patients in Korea, *J Korean Med Sci.* 2020 Feb 24;35(7):e86

9. Kai-Wang To, K., Owen Tak-Yin Tsang, Wai-Shing Leung et al., Temporal profiles of viral load in posterior oropharyngeal saliva samples and serum antibody responses during infection by SARS-CoV-2: an observational cohort study, *Lancet Inf. Dis.*, [https://doi.org/10.1016/S1473-3099\(20\)30196-1](https://doi.org/10.1016/S1473-3099(20)30196-1)
10. Wölfel, R. et al. Virological assessment of hospitalized patients with COVID-2019. *Nature* <https://doi.org/10.1038/s41586-020-2196-x> (2020)
11. R. Li, Sen Pei, B. Chen, Y. Song, T. Zhang, W. Yang, and J. 2020. Shaman, Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus (SARS-CoV-2), *Science*, 368, pp. 489-493, DOI: 10.1126/science.abb3221
12. He, X., Lau, E.H.Y., Wu, P. et al. Temporal dynamics in viral shedding and transmissibility of COVID-19. *Nat Med* (2020). <https://doi.org/10.1038/s41591-020-0869-5>
13. Prakash, Meher K. "Quantitative COVID-19 infectiousness estimate correlating with viral shedding and culturability suggests 68% pre-symptomatic transmissions." *medRxiv* (2020).
14. Randolph, Haley E., and Luis B. Barreiro. "Herd Immunity: Understanding COVID-19." *Immunity* 52.5 (2020): 737-741.
15. Britton, Tom, Frank Ball, and Pieter Trapman. "A mathematical model reveals the influence of population heterogeneity on herd immunity to SARS-CoV-2." *Science* (2020).
16. Bendavid, Eran, et al. "COVID-19 Antibody Seroprevalence in Santa Clara County, California." *MedRxiv* (2020).
17. Levesque, Jérôme, and David W. Maybury. "A note on COVID-19 seroprevalence studies: a meta-analysis using hierarchical modelling." *medRxiv* (2020)
18. Prakash, Meher K., et al. "A minimal and adaptive prediction strategy for critical resource planning in a pandemic." *medRxiv* (2020).
19. Baud, David, et al. "Real estimates of mortality following COVID-19 infection." *The Lancet infectious diseases* (2020)
20. Walker, P. G. T. et al. The Global Impact of COVID-19 and Strategies for Mitigation and Suppression, Preprint at *Spiral* <https://go.nature.com/2yqz47x> (2020).
21. David Adam, The simulations driving the world's response to COVID-19, *Nature*, 580, 316-318 (2020)
22. N. M. Ferguson et al., "Impact of non-pharmaceutical interventions (npis) to reduce covid-19 mortality and healthcare demand," London: Imperial College COVID19 Response Team, March 16 (2020), 10.25561/77482.
23. Flaxman, S. et al. Report 13: Estimating the number of infections and the impact of non-pharmaceutical interventions on COVID-19 in 11 European countries, Preprint at *Spiral* <https://doi.org/10.25561/77731> (2020).
24. Q. Li, X. H. Guan, P. Wu, X. Y. Wang et al., Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia, *N Engl J Med* (2020) <https://www.nejm.org/doi/10.1056/NEJMoa2001316>
25. R. M. Anderson, Hans Heesterbeek, Don Klinkenberg, T Déirdre Hollingsworth, How will country-based mitigation measures influence the course of the COVID-19 epidemic? *Lancet*, **395**, 931-934 (2020)
26. P. Wu, X. Hao, E. H. Y. Lau, J. Y. Wong, K. S. M. Leung, J. T. Wu, B. J. Cowling, G. M. Leung, Real-time tentative assessment of the epidemiological characteristics of novel coronavirus infections in Wuhan, China, as at 22 January 2020. *Euro Surveill.* 25, 2000044 (2020). doi:10.2807/1560-7917.ES.2020.25.3.2000044
27. Kaushal, Shaurya, et al. "Estimating Hidden Asymptomatics, Herd Immunity Threshold and Lockdown Effects using a COVID-19 Specific Model." *arXiv preprint arXiv:2006.00045* (2020)

‘An Open Letter to the UN, G-20, and National Governments on COVID-19 and Agriculture for Food and Nutrition Security on 26 May, 2020’

We are writing to call for a set of internationally coordinated, locally relevant actions to **address the medium- and longer-term impacts of COVID-19 on agriculture, food, and nutrition security**. The current global health crisis has disrupted supply chains and laid bare the need to address the inter-related challenges of hunger, malnutrition, climate change, and environmental degradation and has emphasized the need for concerted, proactive and collective actions to achieve the Sustainable Development Goals (SDGs) adopted by the UN in 2015.

We agree with much that is in the strong statements issued by several leading international entities, including the IMF, World Bank, Food and Agriculture Organization (FAO), International Fund for Agricultural Development (IFAD), World Food Program (WFP), the Committee on World Food Security (CFS), the Food and Land Use Coalition, and the GCARD Road Map by the Global Forum on Agricultural Research (GFAR), the International Dryland Development Commission (IDDC), and the Malabo-Montpellier (MaMo) Panel, among others. The leading research institutions of the world, dialogues organized by the World Food Prize, and many others are nudging the world toward the right direction. Many of these international and regional efforts concerning policy analysis and advocacy agree on the urgent need to strengthen International Agricultural Research and Food Security Systems. We reaffirm these suggestions and **want to emphasize the urgency of real action globally on the ground**.

While the COVID19 pandemic is a major public health crisis, food systems around the world are also under great stress. Consumers are paying higher prices, supply chains are disrupted, children are deprived of school feeding programs and families who rely on food assistance are struggling. Farmers have lost their markets and are worried about harvesting their current crop and planting for the next season. Some governments have responded to the crisis with export bans and import restrictions, which can exacerbate price swings and trade tensions that were already high before the COVID-19 outbreak. Governments must keep trade flows open with sensible export and import policies. Others have responded with humanitarian actions and have tried to ensure the effectiveness and efficiency of the food supply chains. While these efforts have been laudable, they are not at the desired scale. We need to re-build resilient local and regional supply chains based on diversified local food systems and sustainable natural resource management. Concerted actions are urgently needed to ensure crops can be harvested and planted in the coming months and establishing efficient food collection and distribution systems that can deliver nutritious food to hungry people, especially women and children. And while short-term actions to address the crisis are vital, we must also address several long-term implications of the crisis for global food systems.

Achieving the SDGs will require actions on the agriculture and food security fronts, and such actions should be at local, national, regional and global level through a well

monitored and coordinated approach. Before COVID-19 struck, many countries were lagging in attaining the SDGs. COVID-19 will push those efforts further behind, and thus many countries need to reconsider how best to provide for the food and nutrition security of their populations in the event of long-term supply or demand side disruptions due to public health and its economic effects, while still thinking of environmental and climatic factors. Unfortunately, research on these interlinked challenges continues in the silos of environment, agriculture, economics, and public health. We now need more transdisciplinary research to develop more resilience of our agricultural and food security systems in the medium term.

Climate change and the disaster risks it portends has not gone away, even if it has been crowded out of the media headlines by the COVID-19 crisis. But COVID-19 has demonstrated a profound impact that human activities have on our environment. Greenhouse gas emissions are declining; water and air quality are improving; birds and wildlife are returning to forsaken habitats. But we recognize that the economic and social costs of the abrupt economic shutdown are not acceptable over the long term, yet it is an opportunity to re-emphasize the importance of conserving natural resources, especially agro-biodiversity, increasing carbon sequestration, improving soil health and water quality, generation of renewable energy, scientific eco-regional planning, efficient water and nutrient use, diversification, greater dependence on locally available plant-based food systems, etc. These would demand a paradigm shift in national priorities.

Science, Technology, and Innovation (STI) are essential in addressing COVID-19 and other global threats and challenges. The revolution in ICT and in biology can help re-imagine the food and agricultural systems to provide food security to the poor, and to transform the sector by reducing its environmental and climate footprints. Disruptive innovations are needed to increase productivity and income through precision farming and timely delivery of inputs to farmers' fields, through a 'More from Less' approach. research should also help bring new technologies to markets, including 'out-of-the-box' ideas such as meats from single cell proteins to biofuels from algae; from accelerated fish farming to improved livestock breeding to plant-based proteins. Such frameworks should enable rapid movement from 'lab to land' and from 'farm gate to consumer plate'.

Nutrition is important to all human beings at all points of the life cycle. For women, health is a human right; their access to good nutrition is fundamental to ensuring good health and underpinning empowerment. In addition, entire families benefit from the realization of women's right to health; the children of women who are well nourished will be healthier, and those children will avoid stunting and wasting and be able to grow into more active, healthier, and productive young people. Supporting nutritious food and agricultural systems also ensures household nutrition security. The medium and long term COVID-19 response must ensure that the needs of all women, men, and children are met, including those who are most marginalized.

The disruption of input supplies will affect agriculture adversely for the next 6 to 24 months. Urgent action should start now to ensure that adequate credit and agricultural inputs (seeds, fertilizers, and pesticides) are available when and where needed to strengthen the

ability of the farmers to deliver. Transportation, storage and distribution systems need to be enhanced, including the capacity to change production systems to meet shifting demands.

The international community must help the poorest countries with actions on the ground. The World Bank, the Food and Agriculture Organization (FAO), the World Food Program (WFP), the International Fund for Agriculture Development (IFAD) and the Regional Development Banks have all played – and continue to play – important roles in supporting agriculture and food security. Bilateral donors and regional organizations such as the European Union (EU) and the African Union (AU) also have a major role to play. Together they have operational presence in well over 130 countries and can mobilize action for a better future. The CGIAR can enhance the global research system in working on bringing greater resilience to the Food Security system, and enhanced partnerships with National Agricultural Research Systems (NARS), the private sector, and NGOs.

The UN will be holding the Food Systems Summit in 2021. This will be a major opportunity to craft a well-organized global effort to address these challenges. To ensure that the best practices of the few become the standard practices of the many, and that real partnerships for implementing actions on the ground are forged between all governments and the regional banks, bilateral agencies, the private sector, NGOs, and the international organizations to support farmers and consumers in all countries ...

Finally, it is our firm belief that by acting collectively for the common good, motivated by our recognition of our common humanity, and driven by caring and compassion for the poorest and the weakest among us, we can help human society overcome the multi-faceted challenges to the agricultural and food security system brought on by the pandemic, and place society on a much stronger and more sustainable path of growth and balanced development. The time for action is now.
