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WORLD CONFEDERATION OF PRODUCTIVITY SCIENCE

WORLD ACADEMY OF PRODUCTIVITY SCIENCE

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ABOUT US

World Confederation of Productivity Science (WCPS) was founded in 1969 as an apex professional body for promotion and development of Productivity Science across the Globe.WCPS brings together individuals and organisations who share common aims and objectives of Social, Economic and Environment (SEE) Productivity. WCPS regularly organizes World Productivity Congress (WPC) in member countries to deliberate on Topical Productivity Challenges. WCPS also organizes relatively smaller customized Regional Conferences and Seminars for the benefit of Regional participation.

WCPS has two Divisions, World Academy of Productivity Science (WAPS) and World Network of Productivity Organizations (WNPO).

World Academy of Productivity Science is the Academic Division of WCPS engaged in Research, Education, Capacity Building and Knowledge Management. WAPS honors Experts, Academicians, Researchers and Productivity Professionals by inducting them as Fellows of WAPS.

World Network of Productivity Organizations is the Network of Organizations across the Globe engaged in promotion and development of Productivity Science. WNPO organizes events and Training programs with support of member organizations.

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Message From The Desk of Editor in Chief

WAPS' Greatest Resource is Our Fellows

In many countries around the world, longer work weeks do not necessarily translate into higher levels of productivity. To further complicate the matter, COVID-19 started in late 2019 and turned into a pandemic. The global spread of COVID-19 for the past two-plus years have led to a widespread economic contraction and reorganization.

At the start of the 2022 new year, OECD released its latest Economic Outlook report, upgrading its forecasts for this year's global GDP growth to 5.8 percent from its December 2020's 4.2 percent. Despite a brighter global economic outlook, OECD warned that "the world risks an uneven exit from the COVID-19 pandemic unless vaccines are distributed equitably across the globe."

As Fellows of WAPS, more than ever, this is the time for us to bring our skills to bear. Active Fellows are extremely important to WAPS because you directly help promote the development of productivity.

The International Journal of Productivity Science (IJPS*)* is a WAPS' quarterly digital publication aiming to disseminate views and knowledge of experts across disciplines, sectors, geographies, and professions with respect to Social, Environmental and Economic Productivity issues. IJPS is our first step to reacquaint with our Fellows and to reach out to other productivity professionals around the world. I hope you will enjoy this inaugural issue and support publication of future issues by submitting papers and comments.

As I have mentioned before, the Academy's resource is the Fellows' resource. To better organize our resources to contribute to productivity improvement, we are updating our Fellows' profile. An email with a short "Fellow Profile" update was sent to you in late March, and I urge you to send us your updated profile soon to the secretariat (waps@affairs.net.cn) if you have not already done so.

In the same email, we invited you to share your suggestions on how we can bring forward your expertise to enrich potential initiatives we may introduce, build a tighter network for all of us, and how we can involve you, our Fellows, to contribute to productivity development and improvement.

I am delighted to report that a number of Fellows have put forward excellent suggestions. For example, using our respective expertise to lead WAPS initiatives; introducing WAPS chapters in reputable universities and institutions and enroll both faculty and student members to bring about bigger impacts in productivity movement to creating a green and sustainable future; and desiring for the Academy to step up communications with our Fellows. These are all great suggestions and we will find ways to incorporate them into the Academy's activities. And, again, the executive team here highly values your suggestions and thoughts, so please keep them coming.

Our global network of Fellows is giving us an undeniable edge - local knowledge with global reach. Our collective efforts can make a positive difference to our own communities and to those around the world.

Please stay in touch - the executive team and I look forward to hearing from you and meeting you in person soon.

Sincerely yours,

Chen Shengchang

President, WAPS

Message from Chairperson - WCPS

Introduction

First, on behalf of the board of the World Confederation of Productivity Science (WCPS), we welcome readers of our new International Journal of Productivity Science and thank those who have made valuable contributions to our inaugural issue; meaningfully contributing to furthering the development of a global Community that will solely concentrate to building a strong Community of Practice for Productivity Science.

Further congratulations to the board of the World Academy of Productivity Science (WAPS) led by Mr. Chen Shengchang and supported by Dr. Sunil Abrol and Ms. Anita Tang in their drive to have this Journal both created and launched during the COVID-19 pandemic.

As you are aware, tThere are two branches of WCPS - our WAPS branch is responsible for research and the creation of this Journal. WAPS coordinates a five-hundred-strong network of research fellows, and WNPO (World Network of Productivity Organisations) is responsible for supporting the network of WCPS productivity centres.

As with many organisations, the "Pandemic" has thrown our international activities into disarray and uncertainty: the World Confederation of Productivity Science, our organisation, was two months away from launching our 19th World Productivity Congress in India at the International Convention Centre in Bengaluru, in May 2020.

Our World Productivity Congress (WPC) is a major focus of WCPS, and this event planned for May 2020 was twinned with a major World Manufacturing Trade Fair to be hosted by our Indian trade-fair partner, PDA (in Bangalore).

WCPS was established in 1969 and the global WPC has been held in the UK, USA, Canada, China, Australia, India, Chile, South Africa, Malaysia, Norway, and Bahrain. This Indian WPC was therefore building on the success of the previous WPC held in India in 1974.

As always, we in WCPS are interested in progressing the economies and industries of stakeholders, active or benign, that form our network and more broadly who strive to enhance their economic and productivity strategies and most importantly implement them through our global knowledge networks.

Our WPC provides a platform to share current information and provides the environment for "a meeting of minds" to the development of new initiatives and world-class practices which shape the future of productivity growth.

India was selected for this Congress to listen to its key strategies to assist its GDP growth (expected in 2020-2021 to be plus 7% but contracted to 6.6%, while estimated at 8.9% for 2021-2022). Bengaluru, as the "Silicon Valley" of India, had agreed to open the doors of its software parks, and its senior innovation officer and Education Minister for Karnataka had agreed to both support and speak at the event. At that point, the innovative reforms in the macro-economic, fiscal, tax and business reforms had driven this expected GDP growth. The WPC theme selected for 2020 focused on Industry 4.0 - innovation and productivity. This event was reviewing cyber-physical systems that merge the capabilities of humans and machines. As always, this Congress was planned to bring together industry and academia from India and abroad, as well as with participation from representatives from the UN including the United Nations Industrial Development Organisation.

WCPS - Post Pandemic

There are currently a number of countries wishing to take forward the next WPC. The themes of any such congress will

reflect on the needs of their country and the views of the WCPS organisation in relation to challenges post pandemic. India has reaffirmed its interest in hosting a future WPC as has China. The Chinese Association of Productivity Science (CAPS) has had a number of detailed discussions with members of the WCPS board outlining its vision of a "new productivity forum".

As an example, our board is actively discussing on themes such as the role of digital technology to enable a more integrated collaboration for global economic growth; "climate-change" and how green and blue economies can be optimised; the pandemic's impacts on productivity of novel biomedicine and the adverse impacts found in key sectors, these are all worthy of full congress themes and suitable for a Congress review.
In my own country, the UK, we have seen massive impacts on waiting times for hospital treatment and the "lost generations" who have been schooled through the pandemic. In the UK, we have seen a wide range of sectors impacted by the pandemic - I have chosen two sectors to comment on, but these will be sectors that many, if not all economies, now have challenges to resolve: health and education.

Health - number of patients on NHS' waiting lists rose from circa 3.5 million Sep 2019 to 6.48 million April 2022. Between April 2020 (at the start of the pandemic) and March 2022, there are 4.55 million fewer elective procedures and 30.92 million fewer outpatient attendances. We can continue to review health statistics worldwide and I believe the same picture will emerge. So, a key theme for future WCPS research may include innovative approaches in health care to increase productivity. In late 2021, our IOP team in the UK was approached to review best practice in health care.

Education - in terms of the impact of the pandemic in the Education sector, specific pandemic reports have recognised both widespread learning losses and, in some cases, severe learning losses particularly in maths and literacy. The disadvantaged and students from areas of deprivation were reportedly most severely affected. Although this obviously is segmented by age, area, private and public sectors, the impact on these groups was and continues to be significant. As we work in the education sector, we are being requested to consider strategies which can assist students during their learner journey at transition phases - e.g., transit from primary education to secondary education and transit from secondary education into the world of work.

Digital - the role of digital technology tools in assisting both the health sector and education sector to improve productivity is considered important research. The pandemic drove both upscaling and uptake of innovative technologies in the front-line health services in primary care and outpatients. This includes remote monitoring and tele-medicine platforms and tools. Education relied on the increased use of online learning in all areas of education delivery. Further, industry used both education delivery and online tools to verify compliance in areas such as trade.

Final Comments

I would like to extend my best wishes to our new readers - I hope an insight into the role of our World Productivity Congresses for knowledge sharing proves to be of interest to you. Further, we welcome any readers wishing to join WCPS or one of its branches. Hopefully, new members can get involved in contributing articles to the International Journal of Productivity Science or get involved in planning national, regional, and international events.

Sincerely yours,

Mike Dillon

Chairperson WCPS

Message from the President - WCPS

Congratulations to the President of the World Academy of Productivity Science (WAPS) Chen Shengchang and Vice Presidents Sunil Abrol and Anita Tang and their team for the creation of the International Journal of Productivity Science and to the readers of this inaugural edition.

I am delighted to add my comments to those of our Chairperson, Mike Dillon.
My focus is on the future direction of the World Confederation of Productivity Science (WCPS) and its vision and mission.

The mission of WCPS has been the linkage of individuals and organizations around the world who are committed or want to explore productivity improvement as a means of creating wealth and improving the quality of life for regions and nations.

Since 1969, with our first World Productivity Congress (WPC) in London, United Kingdom, our mission stated above has remained the same. However, during the 50+ years since that first event, the world has changed dramatically with global supply chain becoming more integrated and manufacturing and production capabilities in many countries around the world gaining strength.

Massive global technological advancements have occurred over this period.
The geopolitical, economic and productivity balance in the world has shifted.
WCPS's vision and mission is changing to reflect the new reality of the world's productivity and economic environments.

A few examples of geopolitical, economic, and technological advancements over the last 50+ years:

- In 1969, China's GDP was US$79.71 billion. In the first quarter of 2022, it is estimated to be US$18 trillion. China now ranks as the 2nd highest GDP in the world.

- In 1969, India's GDP was US$58.45 billion. In Q1 2022, it is US$3.535 trillion, surpassing the UK, and France, and is now the 5th largest GDP in the world. India has aspirations to capture the world market and become a US$30 trillion GDP economy - enabled by growth in the textile industry - as declared by Union Minister Piyush Goyal.

- The number of smartphone users worldwide reached 6.64 billion by the end of Q1 2022, representing over 66% of the world's population. Market growth in smartphones will be led by Asia Pacific, India, and China in particular.

- Despite these advancements, global productivity enabled by technology has not materialized with the expected benefits. Joel Bell, Chairman of the Chumir Foundation for Ethics in Leadership, is leading a project, "Productive Equity II: Technology, Productivity, Income Distribution," to examine why these productivity benefits have not materialized. "While significant productivity increases in individual deployment have occurred, aggregate national increases, in both developed and developing countries of any importance, have diminished markedly in the last decade or more." WCPS, WAPS, and WNPO are collaborating with the Foundation on this project.

- Digital technology advancements globally have had material impact on many domains such as Industry 4.0, Automotive, Rail, Telecommunications, and other domains. However, the complexity of the possible configurations of the technology ecosystems created goes up exponentially with the number on nodes in the ecosystem. Variant systems testing of these complex systems become increasingly important as the billions of configurations created must be tested properly in order to bring integrity and coherent software-system products to

market. Many countries such as Canada, Sweden, Germany, Turkey, and Portugal are collaborating to provide the latest scientific research and methods to test these highly complex multi-variant configurable systems. Member companies of WCPS are leading participants in this research.

- For climate change, matters requiring global collaboration are urgent. A recent NASA-funded study used a computer climate model to simulate the last 50 years of climate changes. Having validated the accuracy of the computer simulation model for the last 50 years, NASA has used it to predict the next 50 years regardless of whether or not nation states curb their greenhouse gas (GHG) emissions. Under a "business as usual" scenario, global temperatures will be raised to levels that have not existed in the last several hundred thousand years. Significant global collaboration on issues of "green" productivity and "blue" productivity are required to create an alternative scenario of global warming limited to 0.75 degree Celsius in the next 50 years. WCPS will be collaborating with CAPS to create a forum to discuss these issues.

- Many studies of the benefits of global collaboration in bio-pharmaceutical productivity have been completed, much of it examining the increased benefits in leveraging global knowledge and working together in dealing with the Covid-19 pandemic. Those aspirations were only partly realized. While initial collaboration was high in January 2020, by the end of the year, it had dropped to collaboration levels typical of all research. Work needs to be done to create a forum for fostering more collaboration between nation states on bio-pharmaceutical issues that affect humanity and which global application of solutions is required. WCPS will work to provide leadership in enabling these forums.

WCPS' historic mission and vision is expanded to create a platform for dialogue with world leaders on key issues affecting humanity.

In collaboration with the Chinese Association of Productivity Science, WCPS is launching a World New Productivity Forum and the 19th World Productivity Congress in 2023, involving the world's leaders, and international organizations to focus on global collaboration on a major theme and key issues:

- Theme: The new productivity is the material basis for human development and the well-being of human destiny.
- Issues:
- Green productivity
- Blue productivity
- Digital productivity
- Bio-pharmaceutical productivity triggered by the pandemic

Research initiatives

WCPS is discussing with leadership of major research and funding programs regarding WCPS' ability to participate and receive grants for WCPS leadership in those initiatives. These initiatives include and are not limited to:

- **Horizon Europe**: Horizon Europe is the EU's key funding program for research and innovation with a budget of EUR95.5 billion. Horizon Europe tackles climate change, helps to achieve the UN's Sustainable Development Goals and boosts the EU's competitiveness and growth.

- **Eureka**: Eureka is the world's biggest public network for international cooperation in Research and Development and innovation; it is present in 45 countries. In 2021, 200 projects were funded, representing EUR682.5 million Euro, and involving 35 countries.

- **National Research Council of Canada (NRC)**: WCPS is headquartered in Canada and as such has the ability to be

funded by NRC for certain programs. Discussions are underway for WCPS to participate in one or more of NRC sponsored grant programs.

- **Super-Clusters**: Canada has 5 super-clusters across the country, with non-repayable grants as follows:

  - **Digital Technology**: up to CAD173 million
  - **Protein Industries**: up to CAD173 million
  - **Advanced Manufacturing**: up to CAD250 million
  - **Scale AI**: Up to CAD230 million
  - **Ocean**: up to CAD153 million

Sincerely
Peter Watkins
President, WCPS

A Tribute to Dr A. N. Saxena
1925-2021

Dr. A. N. Saxena was an internationally known Productivity & Management Consultant. He retired as the Director General of the National Productivity Council in India in 1985. Thereafter, he was Chair Professor in the faculty of Management Studies (FMS), Delhi University.

Dr. Saxena represented India on the First International Advisory Council of the World Confederation of Productivity Science (WCPS).

In 1988 at the Montreal World Productivity Congress when the World Academy of Productivity Science (WAPS) was setup, he became its First Secretary General, and at the Stockholm World Productivity Congress in 1993, he became the Academy's President.

Dr. Saxena had an unbroken record of over 25 years of participation in World Productivity Congresses held around the world.

WCPS awarded Dr. Saxena the Joseph Faraday Award in Shenyang, China, in 2006.

A Gold Medalist, a Fellow, and a winner of the Special National Productivity Award of the Asian Productivity Organization (APO), Dr. Saxena was empaneled as a Technical Expert under the Technical Expert Service (TES) and rendered professional expert services in Thailand, Malaysia, Nepal, Iran, Indonesia, Turkey, and Mongolia.

As a scholar, a thinker and a writer, Dr. Saxena had published two volumes on Planning & Promotion of Productivity (Indian Experience), besides Management Guides and Training Manuals.

For two decades, Dr. Saxena was editor of the WAPS newsletter, disseminating WAPS/WCPS activities to Fellows, member organizations and other stakeholders.

He had authored the book "Productivity - a Global Movement," based on the history of WCPS. The book highlighted the origins, the Vision and the Mission of WCPS, and uncovered the new horizons of Productivity Science in its wider spectrum of application in all aspects of human endeavor in pursuit of its goal of "Peace and Prosperity Through Productivity."

WAPS/WCPS is indebted to Dr. Saxena for his immense contribution and leadership to the organization. His invaluable role in keeping the WAPS/WCPS flag high and shining will continue to guide us for all times to come.

Smart Cities and the Low-Carbon Economy as Drivers of Productivity

Michael Shepherd, Ph.D.
Trevor Nightingale, Ph.D.

Abstract

The World Confederation of Productivity Science (WCPS) takes a broad, inclusive and holistic view of productivity recognizing that to be sustainable, businesses, governments and other organizations have to address the social, environmental and economic dimensions of productivity. The development of smart cities and low-carbon economies align well with these three dimensions.

Smart city development has progressed from sustainable, to smart, to smart sustainable cities. Throughout, this development, the three pillars of sustainability; social, and economic have remained at the forefront.

In a parallel development, there has been movement towards a low-carbon economy. The triple bottom line of the low-carbon economy, "people-planet-economy", aligns with the three pillars of sustainable cities. Importantly, this triple bottom line and the smart cities' three pillars of sustainability align with the three dimensions of productivity recognized by the WCPS.

This position paper posits that, when viewed through the lens of the WCPS productivity framework, smart cities and low-carbon economies are not just about mitigating climate change, but are in themselves drivers of sustainable productivity.

1. Introduction

We live in a world in which 55 per cent of the world's population lives in cities, and where it is predicted that by the year 2050, 68 per cent of our population will live in cities [1]. Many cities have huge populations, for instance, Tokyo, with a population of 38 million is the largest city by population in the world, the same population as the state of California and the same as all of Canada [2]. Global climate change is putting the world at risk [3] and as cities take up just two per cent of global land area but account for 70 per cent of global emissions, they have a major role to play in mitigating climate change [4].

Since the early 1980s there have been agendas for the development of "sustainable cities" [5, 6], where sustainability is defined by the three pillars of social sustainability, environmental sustainability, and economic sustainability. In the early 1990s the emphasis shifted to "smart" cities, then to "smart sustainable" cities [7]. Recognizing that cities themselves are a significant cause of climate change [4], there has been a considerable effort to address sustainability and, more broadly, climate change through the application of technologies and processes to create climate smart or carbon smart cities [8].

While the names and foci for smart and sustainable cities have evolved over the last 40 years [9], the three central pillars have remained constant over this period [9]. These three pillars are recognized as essential to having liveable and sustainable cities [10].

Over the last few years the low-carbon economy has grown in an effort to combat climate change. A low-carbon economy is based on low-carbon power sources, minimizes the output of greenhouse gas (GHG) emissions into the biosphere, and specifically refers to the greenhouse gas carbon dioxide [11]. Central to the low-carbon economy is the "triple bottom line", articulated as "people-planet-economy", which aligns with the three pillars of social,

environmental and economic sustainability.

This position paper makes two important contributions. The first is to show the alignment of the pillars of smart city development and the triple bottom line of the low-carbon economy movement with the WCPS view of sustainable productivity. The second contribution shows that when viewed through this WCPS lens, smart cities and the low-carbon economy become important drivers of productivity.

The remainder of this paper is organized as follows: section 2 shows the alignment among the WCPS, smart cities, and low-carbon economy models; sections 3 and 4 discuss the evolution of smart cities and the low-carbon economy, respectively; section 5 makes the case for smart cities and the low-carbon movement as drivers of sustainable productivity.

2. Model alignment

2.1. WCPS dimensions of productivity

At the 2008 World Productivity Congress in Sun City, South Africa, the WCPS launched their concept of SEE (Social, Economic, Environmental) productivity, recognizing that to be sustainable in the longer-term, organisations, nations and regions need to improve all of social, environmental and economic productivities so that their operations are socially equitable, environmentally bearable and economically viable [12].

Social productivity is the efficient conduct of social interactions and transactions. Environmental productivity measures an economy's relative efficiency in its use of and impact on natural resources, and economic productivity measures how efficiently goods and services can be produced. Figure 1 illustrates the interaction among these three dimensions of productivity. Sustainable organizations fall in the area at the overlap of the three dimensions.
This is the lens through which we view smart cities and the low-carbon economy. It should be noted that Figures 1, 2 and 3 are essentially the same, illustrating the alignment of the pillars of smart cities, the triple bottom line of a low-carbon economy, and the three dimensions of productivity.

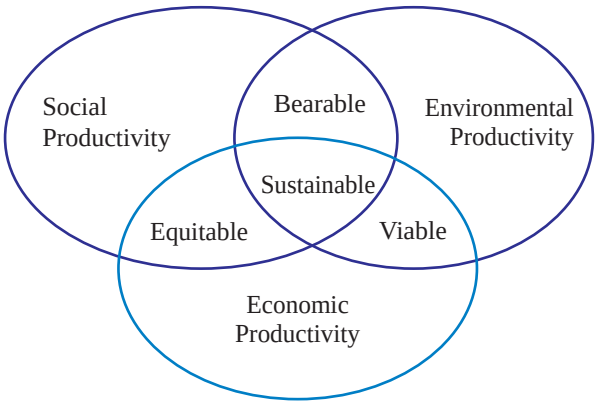

Figure 1. WCPS three dimensions of productivity.

2.2. Sustainability pillars

The concept of sustainability of cities predates the 1960s environmental movements, evolving into the concept of "sustainable development" by the 1980s [9]. The three pillars of sustainable development; social, environmental and economic sustainability are defined as follows [13]:

- Social sustainability is the ability of a social system, such as a city, to function at a defined level of social well-being indefinitely.
- Environmental sustainability is the ability to maintain rates of renewable resource harvest, pollution creation, and non-renewable resource depletion that can be continued indefinitely.
- Economic sustainability is the ability to support a defined level of economic production indefinitely.

Purvis, Mao and Robinson [9] discuss in some detail the origins of the three pillars of sustainability and the three rings as shown in Figure 2.

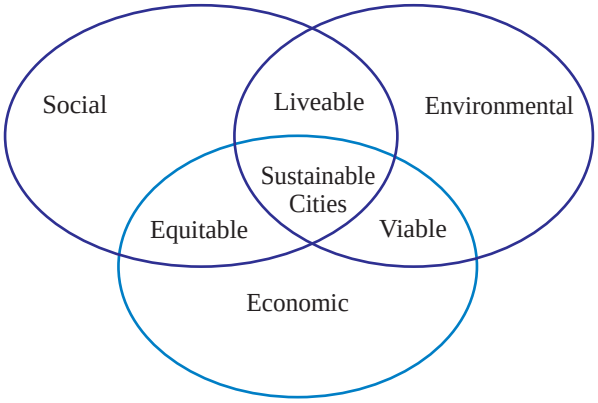

Figure 2. Three pillars for sustainable cities.

2.3. The triple bottom line

Similar to the three pillars of sustainability, the triple bottom line concept is central to the low-carbon economy. Although the "triple bottom line" was first articulated [14] as financial performance, with responsibility for social and environmental concerns, the triple bottom line is now more generally articulated as "people-planet-economy".

These triple bottom line can be defined as follows:

- "People" should be able to live and function in a healthy and safe environment.
- "Planet" should produce less carbon emissions, use less energy, produce less waste and use renewable sources of energy.
- “Economy" will be more sustainable with lower energy costs, carbon taxes avoided, and the monetization of the low-carbon infrastructure.

This triple bottom line aligns closely with the three pillars of sustainability. As an example, a developed country will have building codes that define the minimum legally permissible level of performance for attributes that support key building code objectives which often include health & safety and energy efficiency. Building codes may embody elements that address all three sustainability pillars - people (through health and safety); economic (through energy efficiency); and environmental (carbon emission implicit to energy efficiency).

Figure 3, the Triple Bottom Line for sustainable buildings, is very similar to Figures 1 and 2 and illustrates the realised co-benefits of improved health of people; reduced operating costs; and increased organisational productivity.

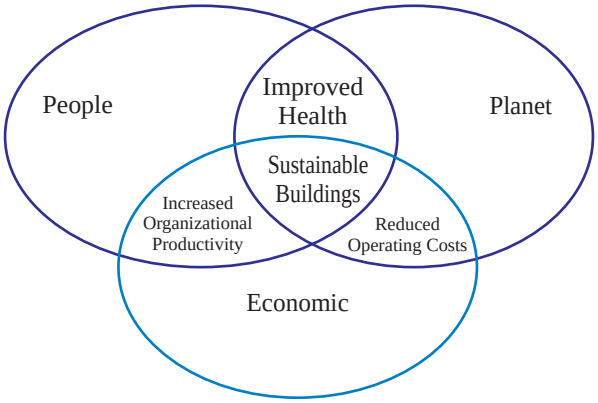

Figure 3. The triple bottom line in sustainable buildings.

3. Smart cities

Over the last 40 years, the thinking on city development has progressed from sustainable, to smart, to smart sustainable, to climate smart cities. What has remained constant throughout this progression has been the three pillars of sustainability.

The term "sustainable cities" was first used in the early 1980s [5] and then in the UN Brundtland Report [6]. The idea of sustainable cities is based on the three pillars of sustainability as described above. Although there are often more pillars included in the discussion, these three sustainability pillars are consistent throughout and virtually all of these additional pillars can be reduced to these essential three pillars.

The concept "smart city" was introduced in 1994 by Dameri and Cocchia [15]. However, a sustainable city does not have to be smart, and a smart city does not have to be sustainable. Similarly, a smart city that has advanced technology embedded in its organization is not necessarily a sustainable city if it does not align strategically with the three pillars of social, environmental and economic sustainability. Ahvenniemi, et al. [7] argue that, "A general goal of smart cities is to improve sustainability with [the] help of technologies." In other words, apply smart technologies to make a city more sustainable. Thus, they suggest that the term "smart sustainable cities" may be more accurate than simply, "smart cities".

Recognizing that cities account for 70 per cent of global emissions, there is now pressure towards the development of climate-smart or carbon-smart cities. The Climate Smart Cities (CSC) program [8] recognises that climate action in many cities depends in part on the presence of a clear, compelling economic case for action. Led by the University of Leeds, and supported by the Centre for Low-carbon Futures, research in the CSC program has pioneered the development of new approaches that examine the economic case for cities to act on climate change. In doing so, the program looks at the case for investing in various sectors, such as transportation, water and waste management.

4. The low-carbon economy

A low-carbon economy is one that minimises the emission of GHG by the end-uses (typically buildings, transportation, agriculture, and manufacturing) and the input energy (typically electricity, and combustible fuels such as oil, and gas) upon which they rely. The 197 countries that pledged to achieve significant carbon reduction under the 2015 "Paris Agreement" [15] and the Glasgow Climate Pact of 2021 [16], have agreed implicitly to develop a low-carbon economy to combat climate change. The degree to which they are successful in developing and maintaining a low-carbon economy will determine the success in achieving the carbon reduction targets in the short and long term, respectively.

Core to a low-carbon economy is policy that steers public and private sector investment and action toward decarbonisation. Policy, while necessary is not sufficient. In addition to policy there must be technical solutions that are both effective and affordable. While there is little disagreement that deep carbon reduction can be achieved (80% by 2050 relative to 2005 levels) what is not clear is what the economically optimal pathway would be [17]. This economic concern is expressed in both the Climate Smart Cities program and the C40 program referenced above.

Low-carbon economies require low-carbon energy and low-carbon materials. Low-carbon energy can be generated through new clean energy generation techniques, clean electricity generation and smart grids, and through de-carbonized gas generation. Low-carbon energy is then used to power low-carbon buildings, low-carbon manufacturing and low-carbon transportation, contributing to a low-carbon economy.

Countries such as Canada have realised significant carbon reduction [18] through greening of the electricity grid by phasing out coal-fired plants and massive integration of renewable energy. While expensive, an accelerated Canadian phase out of coal fired electricity plants has been estimated to result in a reduced future health burden valued at $5 billion [19].

5. Productivity impacts

The alignment of smart cities and low-carbon economies with the three productivity dimensions presented by the WCPS can be leveraged to increase productivity as illustrated by the following few examples.

5.1. Productivity impact of smart cities

While there is still a gulf between the promise of a smart city and the full realization of a smart city, there are obvious areas in which smart cities enhance productivity.

The Global Fund for Cities Development in collaboration with UN Habitat, developed a platform on smart cities with more than 300 cities across the world to evaluate the social impact of smart city investments. Its work suggested that the return on investment in smart public lighting systems is usually seven years and such investment can help lower the cost of the service by up to 75%. Another example can be found in Tokyo (Japan), where the installation of sensors on water pipelines allowed for saving more than a hundred million of litres per year by reducing leaks. Such examples show that smart city investment can have a measurable impact, and also to deliver services and infrastructure for all. [20]

Traffic congestion in major cities is responsible for lost productivity, a decline in social sustainability, and increased GHG. The Hindu [21] reported that lost productivity in Bengaluru due to traffic congestion cost $4 billion USD a year, while the Times of India [22], in a study of four major Indian cities calculated the cost of lost productivity to be $14 billion USD. Even in sparsely populated Canada, the loss is calculated to be about $4 billion CAD per year. [23]
Such lost time is lost productivity, a social loss in terms of time not available for individuals to use for other purposes. Such traffic congestion wastes fuel, which has an impact as both an economic cost and an environmental cost. The release of these carbon emissions into the atmosphere, has consequences for the economy now and for the environment in the years ahead.

Smart city projects such as being undertaken in London can have a major positive impact on traffic congestion. The Smart Mobility Lab is deploying the world's most advanced urban testbed to provide 5G connectivity for connected and autonomous vehicles. O2, the mobile operator enabling the testbed reported that the value of 5G for road management systems could reduce time for motorists stuck in traffic by 10 percent, save the economy £880 million a year, and reduce CO2 emissions by 370,000 metric tons per year. [24]

5.2. Productivity impact of low-carbon economy

Cities account for 70 per cent of global emissions [4] and as every city has buildings, and buildings and construction accounted for 39 per cent of the global emissions [25] in 2017, low-carbon buildings are a cornerstone of a low-carbon economy.

There are assessment and certification frameworks for sustainable (low-carbon) buildings. Industry and NGOs have developed voluntary sustainability programs, such as LEED (USA, Canada), BREEM (UK), HQE (France), etc., to which a building can be certified. To accelerate the uptake of certified sustainable buildings, organisations such as the World Green Building Council and Canada Green Building Council (CaGBC) have demonstrated that buildings certified to their rating system out-perform non-certified buildings in three areas [26]: energy efficiency (and more recently carbon footprint); wellness; and economic value - the triple bottom line.

Voluntary sustainability programs such as LEED [27] have used a balanced score card approach where the designer selects a series of measures from a basket of sustainability options. The number of options incorporated into the design determines the overall sustainability rating. As early versions of the program did not have mandatory energy efficiency requirements, a certified building did not necessarily outperform a non-certified building [28], but on aggregate certified buildings were shown to perform better.

Recently, human resource data have been available to objectively assess organisational productivity [29]. On aggregate, persons working in a certified office building tended to report being happier, and healthier than their counterparts in non-certified buildings. As well, workers in green certified buildings had higher manager assessed performance, were more engaged and more committed to the employer. These studies objectively demonstrated the potential for organisational productivity gains and a triple bottom line improvement through investment in sustainable certified green buildings.

Studies have shown that certified green buildings command a greater leased-rent than a non-green building [30]. However, more work is needed to understand the building attributes that are responsible for the financial benefits; develop key performance indicators and monetise these in a framework for valuation of buildings. Like cities, smart or intelligent buildings make use of data-driven technologies and analytics and/or AI to drive greater operational and energy efficiency, which translates into significant carbon reduction when the input energies are carbon intensive. An example of a smart building attribute could be a retro-commissioning system with automated fault detection and diagnostics to identify inefficiencies in building HVAC operations which when remedied can significantly reduce energy consumption and building operating costs, while having potential to increase occupant comfort.

Going beyond operational carbon reduction, voluntary programs such as the Zero-Carbon Standard of the CaGBC sets a threshold of zero carbon emissions for new and existing buildings [31], while requiring reporting of the estimated total carbon footprint associated with the building over a sixty-year service life to promote low-carbon design and selection of lower carbon materials. The life-cycle assessment can be expanded to include the total cost of ownership (capital for construction and operations and maintenance) over the same period of time. A recent study [29] demonstrated that while a zero-carbon building in Canada will have higher capital cost over its lifespan it will have a positive net-present value compared to a building built to code minimum.

6. Discussion

Throughout the evolution of smart cities the three pillars of sustainability have remained at the forefront. In parallel to sustainable and smart city development, there has been movement towards a low-carbon economy. The triple bottom line of the low-carbon economy aligns with the three pillars of sustainable cities. This potential convergence of the low-carbon economy and sustainable cities can help to dramatically mitigate climate change and will further enhance sustainable productivity.

There are currently many assessment frameworks for smart and sustainable cities, but few if any for an entire low-carbon economy. There are, however, strong assessment frameworks for low-carbon buildings and ultimately there is the potential to expand these to include low-carbon neighbourhoods and low-carbon cities. This would be consistent with the "groundswell" of sub-national initiatives discussed by Bernstein and Hoffmann [33].

An alignment between smart cities and the low-carbon economy assessment frameworks is needed to inform policy and guide investment. Given that the goals of both the smart cities programs and the low-carbon programs are well aligned, an alignment of assessment frameworks would inform sustainable productivity assessment frameworks.

Climate smart cities that adhere to the pillars of social, environmental and economic sustainability and the triple bottom line of "people-planet-economy", will not just have a mitigating effect on climate change, but will be drivers of sustainable productivity.

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Productivity Improvement Crusade - A Tale of 2 Continents

Remi Dairo

Abstract

The idea of productivity dates back to before the 1800s which was principally restricted to agriculture, the production, and consumption of food. Then, another school of thought emerged who saw productivity beyond agriculture to manufacturing and industrial need. (1) The productivity improvement journey moved from experts from different parts of the world and different schools of thought such as Frank Gilbreth, Lilian Gilbreth, George Elton Mayo, Charles E. Sorensen, Frederick Winslow Taylor, and so on but the good news is that the journey never stopped rather the concept of productivity improvement has been moving from generation to generation and nation to nations.

On this same premise, productivity improvement was the establishment of the World Confederation of Productivity Science which started the productivity improvement journey through 2 major platforms - the World Network of Productivity Organizations (WNPO) and the World Academy of Productivity Science (WAPS) to harmonies and promote productivity improvements in national and regional productivity across the globe. (2) The objective of the WPC is great but in reality, how effective is this crusade across the nations of the earth? This journal aims to have a personal-experience insight into the productivity improvement crusade in 2 continents; a critical look at the practice in Africa and America.

My experience as a productivity professional from Africa who practice in Africa and now live and work in America, I have a lot of experience and knowledge to share about productivity improvement campaigns in both continents. This material will help practitioners in the 2 continents or anyone in the productivity space who wants to embark on the productivity improvement journey as work, project, or business. This will be a good material for government and parastatals in the productivity sector to take note of and get insights.

Productivity- A need for all continents

Generally speaking, productivity is the need of every nation, organization, and people. So, whether you are a crusader in Africa or America, improving productivity is a big need. The goal of improving productivity is a song every government sing at every budget year. In Africa, it is said that Labor productivity differences between Sub-Saharan Africa and more advanced economies have remained large. (3) The inefficiencies in the use of technologies in the continent have become more important than undercapitalization in bridging this productivity gap. According to Economy policy; "The gap between productivity and a typical worker's compensation has increased dramatically since 1979" (4) So, productivity improvement is a need of the 2 continents.

Also, during the pandemic, there was a big lesson for the world, no matter the color, race, or tribe, every human being wants to stay alive first before thinking about productivity. The approach by the government may differ but the truth is people work more remotely while the government sent relief packages to homes. In June 2021, an estimated 50% of the South African workforce was working from home full-time (5) while in the United States, 71% work from home (6) This is proof that the pandemic leveled the world in terms of productivity but nations began to find their solutions to survival and productivity. In all the continents of the world, different approaches and solutions were engaged to be able to keep the nation out of hunger.

On the other hand, I categorize the difference between these 2 continents in achieving and enhancing productivity improvement as follows; Structure, Infrastructure, and Culture. With an unbiased perspective, these differences are exposure of strengths, weaknesses, and opportunities for the continents. Readers can find a way to learn, adjust or position for prospecting in the 2 continents as far as productivity improvement crusade is concerned.

Structure

Looking at funding as one of the structures of productivity improvement; the government of America spends so much on developing research and Development that will provoke productivity. According to U.S. Research and Development Funding and Performance: Fact Sheet; "federal funding for R&D grew from $3.5 billion in 1955 to $138.9 billion in 2019, a compound annual growth rate (CAGR) of 5.9%" (7). Africa is also not left out with this effort from the government to improve the productivity of their states. However, Africa's share of global expenditure on research and development remained constant at 1.01% between 2014 and 2018 but, in Sub-Saharan Africa, it dropped from 0.44% to 0.42%. (8) This is very poor and affects the productivity improvement crusade in the continent.

One of the major factors waging war against the campaign of productivity in Africa is funding. Funding and financial support for the industries, small businesses, and even farmers to produce quality farm produce for the nation. In Africa, funding is a big problem, although the government tries in principle most of the time, they are unable to meet up with the huge demand. Africa has so much capacity but lacks funding for major projects and work to increase its productivity. In America, there are pockets of funding for farmers, there are special loans for manufacturing companies and key factors to their national productivity. Another interesting thing is that there is funding for research which is a big drive for productivity improvement. Data has it that Americans spent $138.9 billion in 2019 on research (9). This research cut across, crops, produce pharmaceuticals, and many more. So, working on productivity improvement in this continent already provides you with huge support to succeed.

Labour is another structure of productivity improvement of a nation. Employment is one of the drivers of productivity improvement of a nation. In Africa. Africa continent has the lowest unemployment rate globally, from ages 15 to 24, which is 10.6 percent in 2021; the majority of Africa's youth work casually, and the majority are underemployed or continue to live in poverty despite being occupied with one informal job or the other due to low wages and the lack of social security which makes it difficult to compare African with America. (2021, ILO) (10) The opposite is the case in the United States, according to the bureau of statistics The national unemployment rate, 3.9 percent, declined by 0.3 percentage points over the month and was 2.8 points lower than in December 2020. (11) This made productivity improvement as a way of life rather than lip service by the government.

Professionalism is a major structure that makes a difference in national productivity. The numbers of productivity experts or professionals are less in many African nations compared to America. There are thousands of Productivity coaches, productivity consultants, productivity professionals in America. So, getting human resources to do the job is very readily available compared to Africa where we have a handful of them. The majority of the productivity experts in Africa are government workers working in the public sector. So, they may not be able to effect change in the system they work for as they are constrained by their ministry or the minister's policy per time. In America, there are loads of productivity experts who are private and non-governmental organizations, so they have a voice and can do their work as independent minds without the influence of any government or control. Productivity improvement becomes real and efficient because of the number of productivity professionals in the country.

Another powerful structure that births heavy productivity for nations is inter-trade. The trade barrier in Africa has not been resolved for many years. The Organisation of the African Union (OAU) has been on this course for many years, but they have yet to find a lasting solution. The implication of this is that, there are higher trade taxes in the continent compared to other continents and this is among the factors discouraging trade in African countries (12) Apart from high tariff trade barrier, we have other things impeding the development of trade in African which includes port congestion, technical standards, customs valuation above invoice prices, theft of goods, import permits, antidumping measures, violations of intellectual property rights (IPR), an inefficient bureaucracy, and excessive regulation, and requirements to localize supply. How can you successfully run a productivity improvement campaign? America may not be a perfect haven but the continent has made trade easy for members states while the states have their internal economy system.

Infrastructures

Another important factor to enhance productivity improvement crusade is amenities and infrastructure for productivity such as electric power generation and distribution, availability of cheap internet connections, good roads connection, water, and housing. These are real issues Africa is still battling with for many centuries. So, a productivity crusader may find it hard to navigate hurdles in Africa while to large extent has been taken care of or worked on to the barest minimum. According to Wikipedia "Energy in the United States comes mostly from fossil fuels: in 2020, data showed that 35% of the nation's energy originates from petroleum, 10% from coal, and 34% from natural gas. Nuclear power supplied 9% and renewable energy supplied 12%, mainly from hydroelectric dams and biomass; however, this also includes other renewable sources like wind, geothermal, and solar" (13)

One of the infrastructures of productivity improvement is data; I call it "intangible Infrastructure". It helps to record trends, analyze and predict the future. Without data, productivity science would be difficult to prove some of the assertions made by experts. In America, there is available data and resources to make fresh data available compared to Africa where some data are difficult to find, and where you find such data, it will be external data from other parts of the world. I know there is a lot of work done by scholars in Africa to change this but the reality is that African data by African is hard work. The implication of this is that data from outside Africa can be doctored to suit the perspectives of the researcher and may not be the actual reality captured. So how can you fully pull productivity campaigns through while there is inaccurate or insufficient data? This is the big predicament in the productivity improvement campaign. This also affects policymaking for the continent (14)

Another "intangible infrastructure" that productivity thrives on is security, the case of insecurity and terrorism is a thorn in the flesh for African productivity development. For example, in west Africa, farmers' production has dropped because of the emergence of the "Boko Haram" terrorist group. Many farmers are killed or kidnapped daily and farm produce destroyed because of terrorist activities. The implication of this is that food prices have gone up and the connection between rural places for commercial activities was very difficult and dangerous. (15) How well can you take a productivity improvement campaign to the nooks and crannies of Africa in the face of terrorism. This is not to say there are no new terrorism attacks in the continent of America but you can see control and a high level of peace from rural to urban parts of the states. So, for a productivity improvement campaign to be effective, the security of the experts is very important and that is a big factor.

Apart from security, another infrastructure is good roads and connectivity: African roads and connections may be difficult to deliver maximum productivity because of bad roads. The majority of the produce from farms will not be able to get to the marketplace because of the bad road network. Farmers labor so much to produce food for the continents but transportation and movement of the goods from rural to urban areas is very difficult. Road network and connectivity are very important if we must achieve a productivity improvement drive in Arica. In America, road connectivity is key and the government spends so much on rural roads and connections. The farm produces get to any part of the world right from the farm with some using helicopters or drones to achieve better delivery. Although America's rural areas have their challenge but far better than the rural network in Africa. Data have it that, over 69% of America's Road miles are located in rural areas, totaling over 6 million miles (16) This makes productivity improvement campaigns to be more achievable in this part of the world compared to Africa.

Don't let us forget that productivity improvement has a lot to do with product quality evaluation and marketability. In Africa, it is not that the majority of the products are of less quality but have poor packaging. The packaging from the farm or production center is poor, affecting the quality of the farm produce when it gets to the market. Many of these farm produce will get to the market with poor quality. The point is that the poor packaging is not their doing but they do not have good facility to keep and right packaging for the sustainability of the farm produce and package for the market. This can make productivity improvement journey far as the available farm produce are not well packaged and

marketable. In America, the opposite is the case, farm produce can be well kept safe in a technological silo before coming to the market and good packaging companies are available to partner with the farms to get out the best produce, this gives the productivity campaign a good ride.

Culture

A strong culture that sustains productivity is Education. Education has a great impact on the smooth crusade of Productivity Improvement. Education in this respect covers formal and informal education. African still struggles with educational level, although efforts from government show there is an improvement culture and poverty still hold many downs to the old way of doing things and makes new productivity paradigm a hard job for the crusader. According to Wikipedia, in 2018, 'nearly 9/10 (90 percent) of all adults 25 years or older reported they had completed at least high school or obtained a GED/high school equivalency certificate" (17) Education data stated also that educational attainment among 25- to 29-year-olds in the United States has risen at every level by as much as 80% since the year 2000 (18) This is good backroad for productivity improvement to ride.

You cannot talk about productivity without thinking about the culture of the organization and the nation. America has a learning culture and is receptive to seeking new knowledge which is a big plus for the preparatory ground for productivity improvement. Although there are a lot of organizations that still need to improve on the culture even in America but in Africa, it is a lot of work to break into the organization to teach or install a new culture of productivity. Many organizational leaders and managers in the helms of affairs would rather want to stay with their old ways of doing things and "if it had worked before, it will work again" (thinking mode) This made many of them stay on the old path and find it difficult to be open to a new way of doing things in their organization. When culture is negative towards new improvements in goods, services, or operations, a productivity improvement campaign becomes a difficult task.

The culture of broken policies is an enemy of sustainable productivity improvement. African government has not been able to drive productivity policies home because of this challenge. It is more like lip service than action. There are many policies by the African government but most of the time, it's always on paper without deliberate action, and even when there is action, a change of government is a broken vision and birth of a new policy and direction. This makes it difficult for productivity improvement in Africa. In America, although government makes a policy, they follow through, there could be adjustments if a new party comes in but there are occasions, they say "For the America Dream" They stand as one and move the country forward. Although. In Africa, a change of government means a change in almost all key policies even if they are in the same party. This same challenge we have in organizations when there is a change in new leadership or board. How can you affect change when the new man in the helms of affairs has a different perspective on productivity improvement?

The culture of focusing on self-aggradation above national interest is a major enemy of Africa's productivity improvement. From history, the majority of African leaders are corrupt and this is as a result of selfish leaders here who bring personal interest above national interest. According to Guardian Newspaper of the 8th of December, 2020; about $140bn yearly loss to corruption in Africa. (19) This corruption is said to have affected all spheres of the productivity ecosystem for the state as a result of selfish leaders. When poverty is in play, people lose priority, they focus on survival and living alone for what they can grab not what they can give. The focus of the people will primarily be on tangible and inconsequential things. This way of life, does not prioritize productivity and may not see the need to improve the machinery of production rather ask "What is in it for me?" I am not saying categorically that there is no corruption in the American system but we may say that the level of corruption is high in Africa because of selfish leaders who have been in helms of affairs over the years and this will not be good for productivity improvement sustainability.

Conclusion

In conclusion, I am not in any way writing to bring down Africa but to identify in this journal the challenges of Africa in achieving the full potential that the continent has. African leaders and experts should be ready for the responsibility to

bring the continent out of the dark. America too does have a lot of productivity gaps and they are working hard to bridge the gap. The record has it that U.S. Productivity falls most since 1981 and declining since that time. (20) Productivity is the bedrock of the economy, no matter what level any nation or continent is, there is always a need for improvement. This is the need for productivity experts to understand the continents they are or want to serve and take advantage of the gaps available for more efficient productivity improvement campaigns.

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Technology & Productivity Concept Note: A Multi-Disciplinary 'Look Under the Hood'

Joel Bell

EXECUTIVE SUMMARY

There is a paradox of poor and declining aggregate national productivity, despite the development of new and ostensibly highly productive innovations in their individual deployments. Further, this is accompanied by highly uneven and, ostensibly, inequitable distribution of income. Increasingly, technology critical to national security/defense, to industrial economic strength and to security of supply at competitive unit costs all turn on competitive technological performance. Strength in each is essential to global influence.

Observed performance suggests that current technologies are not contributing all they could to community well-being and policy goals. Despite short term swings in overall productivity occasioned by the timing of innovation and capacity utilization, secular productivity and income distribution have been performing poorly for over a decade on productivity and for decades on income distribution . The causal factors to be examined by this initiative ('the Project') are seen as:

- Market power or dominance of a few suppliers blunts the pressure, extent and timing of the roll-out of new capacities and efficiencies; and, the monopsony power accords these same relatively few dominant firms significant advantages; and favors capital over workers. Growing income disparity reduces demand as higher income-earners spend less of their incomes, further reducing demand for workers and, hence, wages. Both domestic and external political attitudes reflect a consequent malaise and economically counterproductive nationalism.

- Community resistance to initial job displacement from automation and trade - and insufficiency of socio-economic policies and resources for education, training and adjustment. These limit market entry, dissemination of productive advances, and the availability of skilled personnel to capture productive new job opportunities and productivity. Long lead times for the wide implementation of new technologies does give time for policy to adjust.

- Unattributed costs may well exist in the system. The true full-cycle aggregate costs are inevitably captured in data and economic activity, while their allocation to a particular installation or technology may be overlooked. At least initially, those involved may fail to completely anticipate or attribute costs to specific individual deployments that nonetheless undermine aggregate productivity gain. Integrating legacy systems (so-called "technology debt"), unanticipated rejects and downtime - all add to technology innovation costs that are often not built into, at least early, specific technology assessments. This phenomenon is different and distinct from unmeasured productivity impacts from new offerings, both positive and negative, as a result of their not being priced separately. Measurement of productivity calls for more attention.

- **Geopolitical tensions and risks** displace economically optimal investment, as seen currently in the debate regarding China's role in supply chains.

The fundamental technology question is that of whether the inherent characteristics of contemporary technologies (e.g., economic impacts of digital services and their economies of scale and scope; pace of development/obsolescence; unmeasured convenience and features), or market conditions and policy, cause adverse productivity and income distribution consequences. Might different design parameters permit the reshaping of results without productivity

performance penalty? Are the answers different by the type of technology, sector of application and the use and combinations in which new technologies are deployed? The ultimate policy issues are:

- What stimulates technological development and innovation? what substitutes if competitive drivers, information and cross-fertilization - and even lessons from failures - are compromised by non-competitive, security or similar exemptions?

o If technology reaching wide markets is delayed or limited - and, along with it the economic returns - how can the full productivity potential be realized? As market economies have long relied on competition for the motivation for innovation and efficiency, what replaces it and the surveillance it has provided for public interest?

- The exemption of some technologies from policies and practices designed for economic optimization, because the technologies that are argued to be too important for security and defense, removes them from economic and physical optimization. Technology policy and restriction of trade almost always retard the dynamics of development and competitive influence of dissemination and compromise economic optimization and productivity.

o By what criteria, with what selectivity and with what disciplines is economic optimization replaced as the policy driver?

o How can this be managed effectively with the degree of international rivalry and the intermingling of R&D funding, development and deployment of contemporary platforms and applications technologies?

- These same economies have also relied on temporary legal protection of intellectual property monopoly (that retards technological development and competitive dissemination, despite its combination with compulsory disclosure and the fact of some competitive 'inventing around'). Can fixed periods and degrees of such protection optimize results, given the variability of circumstances of different technologies and markets?

o If not, what are alternative policy tools?

o How much, functionally and political reliance should be placed on anti-trust enforcement - or, with what adaptations of remedial methods, in view of contemporary technologies, might that be promising?

In addressing these questions, it is well to reflect on: the facts, costs and tendencies consequent on a security exclusion; small percentages represent very large absolute money sums in many relevant matters; 'big tech' exercises political influence alongside its economic power; and the fact that many of the required assessments are not, by their nature, precise in either cause-and-effect or quantum. Both productivity and geoeconomic/geopolitical consequences turn on the answers and remedies. In fact, technology policy is a central element of international rivalries and a topic for the CSIS-Chumir Global Dialogue.

That disparate income distribution, beyond productive market supply/demand allocation of resources, results from the same four factors as productivity underperformance, suggests an unexploited, even unrecognized, convergence of interests of workers and investors might be found in policies regarding:

- rebalancing of labor power (collective bargaining rights; labor standards of minimum wage and unemployment entitlements);
- skills development and job/worker matching at higher productivity and incomes (education, training, adjustment assistance);
- productivity assessment on fully-allocated, true costs and convenience (avoid arbitrary tax favoring of technology/capital; review full-cycle costs and productivity measures);
- mitigation of geopolitical distortion of investment (technology policy; and co-existence dialogue). A more extensive description and work plan is available.

Extreme-environmental Microorganisms in Agriculture

Zhang Shi-Hong, Shi Yang, Ram Prasad

Abstract:
Agriculture, one of the most important human activities relevant to economy, society and environment, always faces many challenges, among which biotic and abiotic factors must be concerned for their limiting productivity and quality of crops. Sustainable agriculture is the leading direction of agricultural development. However, people only paid more attention to agricultural productivity but ignored the negative impacts of agricultural activities on the environment and ecology; and to obtain satisfied yield, more chemical fertilizers and pesticides have been applied in soils, which constitutes an uncontrollable vicious circle. Microorganism-derived fertilizers and pesticides are alternative to chemically synthesized products. Extreme microorganisms, isolated from hyper stressful environments have robust vitality in compare with ordinary organisms. Within the last few decades, a series of extreme microorganisms have been isolated. The application of the complete microbiomes or typical core microbiomes is going to be the key strategy for sustainable agriculture. Here, we selectively introduced certain useful microorganisms living in the saline obstacle environments and highlighted their function and application in sustainable agriculture.
Key words: Extreme microorganism; Halophilic fungi; soil-remediation

Introduction

To microorganisms, their roles in agriculture seem to be uncertain and over neglected. In the long history, people have been enjoying the material cycle and ecological balance promoted by microbial metabolism. The emergence of chemical fertilizers and pesticides, like the Hiroshima Atomic Bomb, has broken the silence of ecological balance. Chemical fertilizers and pesticides are double-edged swords for agriculture. And indeed, according to statistical data from UN food and agriculture Organization (FAO) and Ministry of Agriculture and Rural Affairs of the People's Republic of China (MOA), Fertilizer contributes near to 50% to the increase of world crop production, and pesticide use saves about 40% of the world's total crop production (MOA 2015, FAO 2015). However, fertilizers and pesticides lead to unwanted consequences, such as degraded soil fertility, excessive pesticide residues, and agricultural non-point source pollution. Particularly, Excessive use of pesticides and fertilizers influences the safety of the ecological environment and agricultural production, and further threatens human health and sustainable agricultural development. People are crazy to pursue the pleasure brought by ultra-high output of crops but have to stand the cost of unhealthy food. With finite resources, the pressure of the growing global population and human physical and mental health, we need a plan to stimulate action in areas of critical importance for agriculture.

In September 2015, the United Nations launched the Sustainable Development Goals. For developing countries with large populations such as China and India, this initiative has far-reaching significance. In order to deeply understand the connotation of the high-quality development of green agriculture and implement the ecological concept of "Nature is the true treasure"; and in order to promote the pace of ecological civilization in the developing countries and accelerate the rapid development of global modern agriculture, the International Symposium on Soil Fertility Improvement & Ecological Restoration in the Great Bend of Yellow River-Onsite Meeting for the Green Circulating Agriculture Based on Organic Fertilizer from Decomposed Straw was held in Tuoketuo County, Inner Mongolia, on July 31, 2019. The main theme of the conference is "Green, Cyclic, Health and Sustainability ". Fortunately, we were invited to attend and make keynote speeches at the conference. The Yellow River has bred the Chinese national culture, and the Great Bend of Yellow River (Hetao in Chinese) has laid the material foundation of China. "Harmful sometime the yellow river flooding, but makes wealth in the great bend". However, in today's Hetao, fertile fields disappeared, instead of which salt thorns are clustered. This is caused by man-made and unscientific farming system, especially the over-utility of chemical fertilizers, pesticides, and secondary disaster by flood irrigation. As fungal biotechnologists, our research has direct applications that contribute towards solving these problems. At the conference, we discussed a lot about how to emphasize the role of beneficial microorganisms in agriculture. We sincerely hope agronomists and micrologists who

work together with this fascinating group of organisms to improve the welfare of our planet and mankind.

Modern agriculture should be sufficient, organic and healthy agriculture. World agriculture is rapidly stepping into scale, intensiveness and modernization. Certainly not limited to China and Indian, there are many technical problems facing in the development of modern agriculture, among which the problems of soil conservation tillage and fertility upgrading, and harmless treatment of crop straw and efficient utilization are the most urgent ones. Human beings have always benefited from beneficial microorganisms, but we don't turn a blind eye to them until today. Therefore, A safe alternative to fertilizers and pesticides is becoming increasingly urgent.

Most halophilic organisms from different extreme-environments have been isolated mainly from oceans or related places with a high concentration of salt, such as the famous Dead Sea (Moubasher et al. 1990; Arakaki et al. 2013). In cold desert, Antarctic, or other specific extreme environments, many extreme organisms exist with specific resistance against to the single extreme environmental factor, but also confer strong resistant ability to other extreme conditions. Till now, many studies on biodiversity and physiology have focused on the characterization of halophilic fungi present in saline and hypersaline ecosystems. Many species in ascomycetes and some in basidiomycetes have been described with the ability to grow in these environments.

Halophilic microorganisms

Ancient Earth was covered in a global ocean (Burnham and Berry 2017). Studies on the microbial communities of deep subsurface sediments, saline lakes, or desert soils with variable salinity levels have indicated the presence of Bacteria and Archaea, containing a number of ubiquitous phyla including Actinobacteria, Bacteroidetes and Proteobacteria (Fierer et al., 2009). A series of strains isolated from the vent of submarine volcano show not only halotolerance but also thermotolerance. In addition, Pyrococcus abyssi, Sulfolobus acidocaldarius, Thermococcus kodakarensis, and Thermotoga neapolitana make them best laboratory models for understanding the mechanisms that they have evolved to live under hostile environmental conditions. Another halotolerant Exiguobacterium strain was isolated from Salar de Huasco, is ideal for the study on resistant mechanism and the evolution of adaptation (Remonsellez et al., 2018).

Early researches focused on prokaryotes grow under salt stress and populate saline ecosystems such as Eubacteria, Archaea and Algae (Oren 2002). Microbial eukaryotes also appeared in deep-sea subsurface sediments; and fungi are the most consistently detected eukaryotes in the marine sedimentary subsurface (Edgcomb et al. 2011). Most marine-derived fungi belong to halotolerant fungi which live in saline environments but do not necessarily require certain concentrations of salt; the rest of marine-derived fungi are classed as halophilic fungi because these fungi require salt concentrations of at least 0.3 M (sodium salt, e.g. NaCl) to grow optimally, and even they thrive in high-salt environments (Arakaki et al. 2014). Over the last two decades, marine fungi have been discovered accordingly in the saline environments such as in the Dead Sea, Atlantic Ocean, China Sea (Grishkan et al. 2003; Nazareth et al. 2012), and the solar salterns near to seacoast (Cantrell et al. 2006; Nayak et al. 2012). A large number of studies on biodiversity and physiology have focused on the characterization of halophilic fungi present in the sea related saline and hypersaline ecosystems, among which Ascomycetes and Basidiomycetes have been described (Gunde-Cimerman et al. 2000; Gunde-Cimerman and Zalar 2014). In general, fungal communities in hypersaline environments are dominated by Aspergillus, Penicillium and some of their teleomorphic genera. Other genera such as Alternaria, Cladosporium, Fusarium, Chaetomium, Wallemia and Hortaea were also reported (Moubasher et al. 2018). Some new species were also described from hypersaline environments including three Gymnoascus species.

Some special extreme-environments are favor to isolate the halotolerant or halophilic microorganisms. A variety of filamentous fungi have been isolated from the Dead Sea, including Gymnascella marismortui isolated from the surface water down to a depth of 300 m (Buchalo et al. 1998). G. marismortui is adapted to high-salt conditions and requires high salt concentrations (Buchalo et al. 1998; 2000). In addtrion, 476 fungal isolates were isolated consistently from the Dead Sea and probably form the stable core of the fungal community, including Aspergillus terreus, A. sydowii, A.

versicolor, Eurotium herbariorum, Penicillium westlingii, Cladosporium cladosporoides and Cladosporium sphaerospermum. However, most fungal isolates from the Dead Sea belong to the genera Eurotium and Aspergillus (Yan et al. 2005).

Lake Magadi is a hypersaline location in the East African Rift valley, Kenya. 52 fungal isolates in Lake Magadi were characterized with different pH, temperature and salinity ranges, respectively (Orwa et al. 2020). These isolates were affiliated to 18 different genera with Aspergillus, Penicillium, Cladosporium, Phoma and Acremonium being dominant. Interestingly, the different isolates could produce diverse extracellular enzymes, such as proteases, chitinases, cellulases, amylases, pectinases and lipases. In addition, antimicrobial metabolites were noted for isolate 11M affiliated to Penicillium chrysogenum (99%). Cell free extracts and crude extracts from isolate 11M had inhibitory effects on both animal and plant pathogens, indicating the promising application potential in biological protection.

China has remarkable biodiversity and many typical hypersaline environments. Research aimed at isolating and characterizing halotolerant or halophilic fungi from seas, has progressed rapidly. A series of promising halophilic fungi, including Aspergillus glaucus CCHA, have been reported (Liu et al., 2011). Three marine-derived isolates were collected in Wenchang, Hainan Province, China, and identified as extremely halotolerant fungi: Wallemia sebi PXP-89, P. chrysogenum PXP-55, and Cladosporium cladosporioides PXP-49 (Xu et al. 2011).In addition, 188 marine-derived fungi were collected from the sediment in Zhoushan Sea area, the mangrove at Yunxiao Country and Jiulongjang estuary in Fujian Province, China (Xiao et al. 2005), of which the ethyl acetate extract of strain 164 exhibited strong lethal effect on nematode Rhabditis sp. In another research, 31 nematode-trapping fungi recorded from mangrove habitat of Hong Kong were identified Arthrobotrys, Monacrosporium, and Dactylella (Swe et al. 2009). The South China Sea covers a vast area. The diversity of fungal communities in nine different deep-sea sediment samples of the South China Sea were isolated by culture-dependent methods followed by analysis of fungal internal transcribed spacer sequences (Zhang et al. 2013), in which 13 of 27 identified species were firstly reported. Moreover, 3 isolates might be novel phylotypes of genera Ajellomyces, Podosordaria, Torula, and Xylaria.

Many terrestrial halotolerant fungi have been characterized. Chamekh et al. (2019) identified 136 isolates from the soil of the Great Sebkha of Oran located in northwestern of Algeria. Wallemia sp. H15, Gymnoascus halophilus H19 and H20 are obligatorily halophilic, but most isolates are halotolerant, which can still grow on PDA medium without NaCl, indicating the dominant flora of halotolerant fungi. 74% of the strains could grow at 12.5% NaCl and 5 strains (A. subramanianii strain A1, Aspergillus sp. strain A4, P. vinaceum and the two strains of G. halophilus) at 17.5%. The only strain that could grow at 20% was Wallemia sp. The optimum growth of most strains is 2.5% or 5% NaCl. The concentration of 10% is optimal for the growth of G. halophilus. The halophilic fungus A. glaucus CCHA from air-dried wild vegetation has been analyzed (Liu et al. 2011). This species shows extreme salt tolerance, with a salinity range of 5 to 32% (NaCl) required for growth. Interestingly, A. glaucus CCHA survives in solutions with a broad pH range of 2.0-11.5, indicating that it is a haloalkaliphilic fungus. Further investigation indicated that increasing the pH value (> 8.0) can induce A. glaucus CCHA to produce a variety of organic acids, including citric acid, oxalic acid and malic acid. In addition, A. glaucus CCHA shows resistance to aridity, heavy metal ions, and high temperature (Liu et al. 2011). The extremophilic nature of A. glaucus CCHA suggests that it has great promise in soil remediation applications (Fig 1).

Control Field **Test Field**

Fig X.1 Mycoremediation of salt-affected soil using amendments supplemented with saline tolerant fungi (Aspergillus glaucus CCHA and Aspergillus terreus (ratio = 1:1)). The experiment was conducted in salt-affected soil in Dalian, Liaoning province, China. The photos were taken in 2020.

Prospects

Abiotic stresses that influence agriculture include soil salinity, drought and extreme high or low temperatures. Second salinization or such as contaminations caused by overusing chemical fertilizers actually belong to abiotic stress as well. Scientific utilization of beneficial extreme-microorganisms is an important means to reduce harms to agriculture. Microbial application for amelioration of saline soils is gaining popularity due to its better amelioration and reduction in economic and environmental costs. Microorganisms with different roles play function synergistically in a defined extreme environment. The identification and application of the complete microbiomes or typical core microbiomes is going to be the key strategy for sustainable agriculture. It is clear that despite the advances, more researches are required to realize the potential of sustainable fungal environmental biotechnology. Agronomists and micrologists must work together with this fascinating group of organisms to improve the welfare of our planet and mankind.

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Carbon Farming
Can Be A Big Contributor To Carbon Neutrality

MOM Foundation

Abstract

To combat climate change and reduce greenhouse-gas emission, abundant resources are being put into clean energy, renewable energy, and other related technologies, but without certainty being guaranteed.

Carbon farming, though still at a very early stage of exploration and with a lot of unknown, can be a potentially big contributor to help reduce carbon emission and mitigate climate change. At the least, carbon farming can help farmer improve soil quality, increase farm productivity and thus profitability.

In this paper, we first look at what carbon farming is all about, and as a whole-farm approach, how it can drive a system change in agriculture - reversing its leading position as a contributor to global carbon emissions and transforming it to a net sink. Though at a preliminary development stage, the combined activities of education, knowledge transfer, soil restoration and product-yield improvement, together with carbon-credit development, recognized practice and appropriate incentive for stakeholders, the agriculture community can help reduce or offset emissions through the practice of carbon farming.

The Movimiento Organico Mexicano Foundation (M.O.M.) is starting this movement by bringing awareness to the farmers and the agricultural value chain. There is a good Chinese saying, "Journey of a thousand miles begins with a first step." M.O.M. is bringing about the awareness of carbon farming and its potential benefit to humankind in our embarkment of this sustainability journey.

With the help of experts and conscientious people, M.O.M. contributes to the repair of the environment, researching, disseminating, and acting in such a way that we transform the educational, cultural, economic, and spiritual processes that allow us to complete the ecological cycle of life on the planet.
Email: info@mom-mundo.org

Overview

Agriculture and forestry practices account for at least 24 percent of global carbon emissions. Under current land management practices, agriculture remains one of the leading contributors to global carbon emissions. However, it is the only economic sector with the potential to transform itself from a net carbon emitter to a net sink using practices broadly classified as "carbon farming."

Carbon farming practices can help remove carbon dioxide from the atmosphere, and store it for long periods of time in soil, microorganisms, and plant matter. Climate scientists estimate that 200 billion tons of carbon dioxide would need to be removed from the atmosphere to halt and begin to reverse the effects of climate change. The world's agricultural soils can meet this challenge if we change the way we grow food.

According to a study by The National Academy of Sciences, "global farmland could capture and store as much as 3 billion tons of additional carbon dioxide if farmers adopted a number of improved practices, including adding organic matter like manure or compost, shifting cultivation to favor crops that contribute more of their carbon to the soil, or using offseason to plant cover crops."

I. Carbon Farming and Its Benefits

What is Carbon Farming?

Carbon farming is a broad set of agricultural practices across a variety of farm types that result in increased storage of atmospheric carbon in the soil. Many of these practices are common in organic farming, regenerative agriculture, permaculture, and other approaches to food production.

When plants photosynthesize, they remove carbon dioxide from the atmosphere and store it. When they die, this carbon is either released back into the atmosphere or it is stored for long periods of time in the soil. Many conventional agriculture practices result in the release of carbon, while practices classified under carbon farming aim to do the opposite.

Some examples of practices that farmers or gardeners can employ to help sequester carbon and improve soil health include:

- Leftover biomass is returned to the soil as mulch after harvest instead of being removed or burned.
- Conventional tillage practices are replaced by conservation tillage, no till, and/or mulch farming.
- Cover crops are grown during the off-season instead of leaving croplands bare.
- Continuous monocultures are replaced by high-diversity crop rotations and integrated farming practices.
- Intensive use of chemical fertilizers is replaced by integrated nutrient management and precision farming.
- Intensive cropping is replaced by croplands integrated with trees and livestock.
- Surface flood-irrigation is replaced by drip, furrow, or sub-irrigation.
- The indiscriminate use of pesticides is replaced by integrated pest management techniques.
- Marginal and degraded soils are restored to their natural states instead of being used as cropland.

Many of these practices can be used in combination with one another or applied one at a time. Almost all crop land can be improved with these practices and more.

Benefits of Carbon Farming

In addition to offsetting emissions, carbon-farming practices have the added benefits of restoring degraded soils, enhancing crop production, and reducing pollution by minimizing erosion and nutrient runoff, purifying surface and groundwater, and increasing microbial activity and soil biodiversity.

The added benefits of carbon farming mean that more food can be produced with less pollution while building soil and sequestering carbon dioxide. If accomplished at a large enough scale, carbon-farming practices have the potential to begin to reverse the catastrophic effects of climate change. Promoting and growing the use of these practices is one of the best avenues for meeting carbon-emissions-reduction goals and mitigating climate change.

II.Carbon Farming is A Whole-Farm Approach

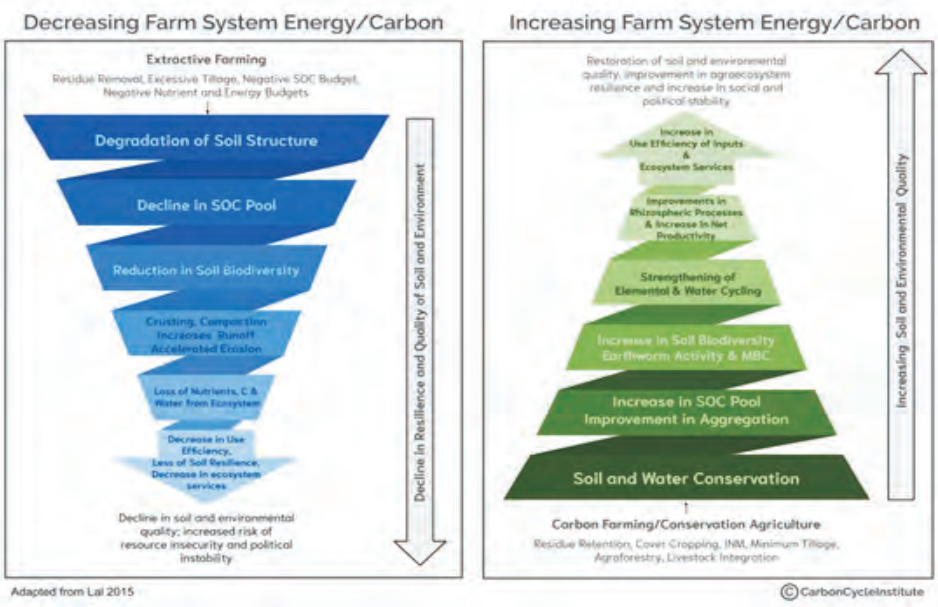
Carbon farming as a whole-farm approach is to optimize carbon capture on working landscapes by implementing practices that are known to improve the rate at which CO2 is removed from the atmosphere and stored in plant material and/or soil organic matter. Carbon farming is a framework for engaging with the agroecosystem processes that drive system change.

Carbon is the Carrier of Energy within the Farm System

Carbon farming explicitly recognizes that it is solar energy that drives farm ecosystem dynamics and that carbon is the carrier of that energy within the farm system. Carbon farming is synonymous with the term "regenerative agriculture" when that term is explicitly rooted in an understanding of the underlying system dynamics and positive feedback processes that actually make a "regenerative" upward spiral of soil fertility and farm productivity possible, as depicted

in Figure-1.

Figure-1: Regenerative Agriculture

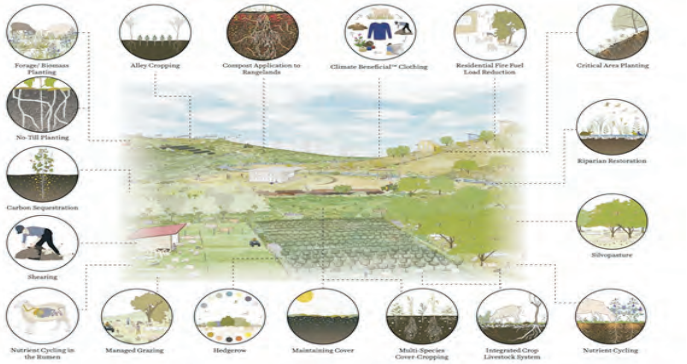


Aldo Leopold defined soil fertility as the "ability of the soil to receive, store and release energy," a succinct definition of "soil health." Recognizing that carbon is the energy currency of living systems - as the medium through which solar energy enters and radiates throughout the food web and the farm system - carbon farming focuses on opportunities for increasing the capacity of the farm system to "receive, store and release" that energy; as work, as system processes, and as biological and structural diversity within the farm ecosystem, particularly recognizing the critical role of soil organic matter as both a sink for solar energy and as driver of both soil and overall agroecosystem dynamics. Carbon farming is successful when carbon gains resulting from enhanced land management and/or conservation practices exceed carbon losses.

Carbon Farming Practices

Carbon farming practices are management practices that are known to sequester carbon and/or reduce greenhouse gas (GHG) emissions. At least 35 of these practices are identified by the Natural Resource Conservation Service (NRCS) as conservation practices that improve soil health and sequester carbon while producing important co-benefits, including: increased soil water holding capacity, hydrological function, biodiversity, and resilience. See Figure-2.

Figure-2: Carbon Farming Practices



Source: Carbon Cycle Institute, *https://www.carboncycle.org/what-is-carbon-farming*

But, there is still a lot we do not know about the extent of carbon farming and how it benefits sustainability efforts to mitigate climate change.

Noah Deich, Executive Director of Carbon180: "There are still a lot of unknowns about how soil microbe ecosystems actually work and what practices are most effective at capturing and storing carbon dioxide."

Tim Searchinger, Princeton Researcher: "There may be limits on what farmers can do to change their soil management practices. And, we still don't know how much more carbon farmers can store in soil that is continually farmed."
David Stark, President of Holganix Agriculture: "While there is a lot we still don't know about carbon farming, we do know that incorporating carbon farming practices improves soil health which can improve crop yield and farm profitability. We also know that carbon farming practices can promote a farm's sustainability practices."

III.Increase Farm Profitability
Farmers are beginning to look into carbon farming as a method to increase farm profitability, improve soil quality, and to help combat climate change.

According to an article by AgProfessional, "the global carbon market is estimated at US$160 billion." Indigo Agriculture has stated publicly that it believes there is a US$15 trillion opportunity to sequester carbon for farms.

Regardless of the size of the market for carbon sequestration, most experts agree that the practices that sequester carbon also happen to be better for the overall health of the soil. Practices like no-till/strip-till, sub-surface application of nutrients, and the use of cover crops among others, help increase organic matter, reduce erosion, and improve soil resilience in addition to sequestering carbon. They are all positive for the long-term health of the soil.

In addition to improving soil quality which could translate to improved yield, farmers could be paid carbon credits by private companies or government agencies to promote the practice, ultimately providing additional revenue to the farm.

Carbon-Market Participation
As for all markets, carbon markets require buyers and sellers:

- A buyer of carbon offsets would be an entity needing to reduce or offset emissions. The largest buyers of carbon offsets are likely to be the largest emitters, such as power plants, transportation companies, and industry as a whole.

- Potential sellers come from various sources such as agricultural farms and ranches, wind farms, and hydroelectric plants, among others.

In general, suppliers of GHG offsets can sell their offsets through direct contracts with buyers or through a carbon exchange. A potential hurdle for agriculturists to participate in the carbon exchange is to meet the minimum entry requirements (a minimum of certain CO2e may mean an acreage that few may own), which means that they have to work with an aggregator (an entity that pools or aggregates producers and combines carbon credits from agricultural offset projects initiated by farmers, ranchers, and private forest owners).

There are two main categories of carbon markets: voluntary markets and compliance markets. Voluntary carbon markets serve businesses and individuals who wish to offset some or all of their GHG emissions to accomplish business or personal sustainability goals but who are not legally required to do so. Compliance carbon markets serve regulated entities that are legally required to reduce their GHG emissions.

How Agriculturists can Reduce or Offset Emissions

Farmers and ranchers can participate in the offset process by either reducing emissions or by capturing and storing emissions. In fact, most tonnage of potential soil-carbon storage come from forest management activities - avoided grassland conversion to cropland, and planting cover crops.

To reduce emissions, producers can:

- decrease fertilization
- alter manure management
- reduce fuel consumption
- change feeding practices
- switch to alternative fuels, such as from coal to natural gas or bioenergy
- produce biofuels feedstock
- implement rotational grazing programs

Agriculturists can also capture and store emissions in a process called sequestration. One type of sequestration is biological sequestration, which uses the characteristics of plants to capture emissions. Agricultural forms of biological sequestration include:

- changes in tillage practices
- crop rotations
- conversion of acreage to grasslands
- afforestation - planting of trees or seeds to change open land into forest or woodland

A practice that both reduces and sequesters emissions is the reduction of stocking rates.

However, these activities are costly, and producers must have an economic incentive to change their production practices to participate in the carbon market.

Three Key Things for a Farm to Earn Carbon Credits

In the United State, for a farm to get ready to earn carbon credits, attention should be paid to these three things: the impact of capturing farm data, how carbon credits affect lease income, and the evolving value of carbon credits.

1. Capturing Farm Data: Having good records and accurate data is the gateway to participating in carbon markets. Carbon markets work by rewarding the implementation of practices that sequester more carbon than the status quo. To earn a credit, a farmer or landowner must prove that they have implemented a practice that sequesters carbon, underscoring the importance of capturing quality farm data.

2. Impact of carbon credits on lease income: How to incorporate the revenue from carbon credits into the farm lease agreement depends on what type of lease arrangement the landowner has with the farmer.

3. Evolving value of carbon credits: The long-term success of carbon markets is unknown, but they are gaining substantial momentum and most industry players now offer some type of solution. More importantly, the practices that carbon credits promote will have a very real impact on the value of the farm with an increased focus on the long-term benefits that they create. A more resilient farm with high organic matter should sell for more because it is more productive and has lower-input costs.

It is important to note that there is a key drawback of agricultural carbon credits in leased cropland because when the carbon contract expires, the land can be plowed up and the stored carbon released back into the atmosphere. One

solution at the moment is to sign long-term agricultural carbon contracts - 10-20 years or more. As for forests, the issue is not as acute because they are managed on a longer timeframe than cropland.

IV.Agricultural Carbon-Credit Market Today

"How to Grow and Sell Carbon Credits in U.S. Agriculture" is a report released by Iowa State University Extension and Outreach, updated in November 2021: a set of 26 questions based on conversations with farmers and agricultural stakeholders was developed, and answered based on publicly available information collected via online search and interviews with representatives from some of the 11 carbon programs.

The report summarized its findings as follows:

• The emerging agriculture credits market can be currently characterized as an unarticulated patch of coexisting programs with different rules, incentives, and penalties, rather than as a cohesive and transparent market where the same activity has the same implication across programs.

• In its formative stage, the incipient agriculture credits market is very dynamic, focused on testing protocols through small-scale pilot programs, and lacks transparency and liquidity. While all programs require additionality to generate a credit, not all programs require that farmers change their production practices.

• Additionality means that farmers must do something different to reduce carbon and increase ecosystem services. However, programs use a wide array of benchmarks to determine what is different. Some programs require a change of practices with respect to past practices on the same field, while some others require that practices in the field be different from common practices in the area (even if the same practices have been implemented for many years in the field under consideration).

• With the exception of Bayer Carbon, which compensates farmers for implemented practices, all other programs compensate farmers for carbon-credit generation.

For farmers to participate in the carbon-credit market more confidently, there should be some sort of standardization of equivalences for farming practices across initiatives, with the introduction of transferable partial-and-full-credits across protocols, so that the farmers' risk can be better mitigated.

Iowa State University Extension and Outreach's market assessment is echoed by J. David Aiken in his April 21, 2021 Agricultural Economics article, titled "Ag Carbon Credits." Aiken noted that the agricultural carbon-credit market today is "the wild, wild west" with no rules or regulations exist. The two largest players in the market, he pointed out, are speculators and pilot-project developers.

Aiken described speculators as people who are attempting to contract as many acres as they can with the expectation that carbon market will explode in the next few years and they will sell their carbon credits at a large profit. Pilot projects are being developed by several different groups, many with agribusiness partners or connections. The basic idea is to sign up some acres and use them as a test to develop the soil carbon-storage information to credibly document that the improved management practices have sequestered more carbon in the farm or ranch land. These firms or groups want to be the intermediary between ag producers and carbon markets or carbon-credit buyers over the long haul.

V. Going Forward

Great attention is placed in replacing conventional energy sources with clean energy and renewable energy, carbon-capture-and-storage technologies, and others, which demand time and huge financial resources but involve much uncertainty. Great emphasis is also put in GHG emission and manufacturing, while a very basic element in our everyday

life - farming and GHG emission - is mostly overlooked.

Rodale Institute's research, "Regenerative Organic Agricultural and Climate Change," suggested that the "Net Zero CO2" discussion should be redirected from the "swarm" to the "simple." An obvious and immediately available solution, it noted, is to put the carbon back to work in the terrestrial carbon "sinks" that are literally right beneath our feet.

Agriculture and forestry practices account for at least 24 percent of global carbon emissions. Under current land-management practices, agriculture remains one of the leading contributors to global carbon emissions. However, it is the only economic sector with the potential to transform itself from a net carbon emitter to a net sink using carbon farming. While experts noted that there are still a lot we do not know about carbon farming, we do know that incorporating carbon-farming practices improve soil health which can improve crop yield and farm profitability.

The United States government, institutions and businesses are starting to explore how they can help the farmers improve their yields, restore the land, and sell farm carbon credits. No other country is known yet to have put in much effort in this area.

The United Nations is expecting the world population to increase by 2 billion people in the next 30 years to reach 9.7 billion in 2050. With limited availability of arable land and increasing demand to produce food to feed the world population, being able to improve crop yields, retore the land, increase farmers' profitability by helping them sell farm carbon credit, and at the same time combat climate change should be a multiple-win undertaking for countries and regions in the world.

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Big Skills Strategy for Productive Project Execution

Dr. Sunil Abrol

As soon as the London Olympics 2012 were awarded to Great Britain, British Government set up in 2006 Olympics Development Authority (ODA), a body headed by one of the ministers in British Cabinet. One of the considerations before ODA was while organizing the London Olympics 2012 event successfully, it must also contribute to socio - economic benefits to UK, particularly five Host Boroughs. Namely Tower Hamlets, Greenwich, Hackney, Newham and Watham Forest. The strategy adopted by ODA was based on white paper titled "Job skills Futures 2008 which focused on ensuring skilled workforce deployment, increased employment for locals particularly women, disabled persons and minorities by contractors for construction of venues & infrastructure as well as staging the London Olympics 2012, as envisaged in Equality, Inclusion, Employment and Skills (EIES) program.

Skill Development Strategy

The development and execution of employment and skill development strategy for the London Olympics 2012, was done by two organisations i.e. ODA and London Organising Committee of the Olympics and Paralympics Games(LOCOG). ODA was the public body responsible for developing and building the new venues and infrastructure for the London Olympics 2012. LOCOG was a private company responsible for preparing and staging the London Olympics 2012.

While ODA focused primarily on construction related activities LOCOG was responsible for non-construction activities like catering, retail, security, volunteering etc.

ODA Strategy for Employment & Skilling

ODA Strategy aimed at:

- Promote sustainable employment opportunities and boost skills locally and across UK.
- Encourage contractors to pay the London living wage
- Deliver a construction workforce of at least 10-15% from five host Boroughs
- Ensure at least 7% of workforce is made up of previously unemployed before working on London 2012.
- Place at least 2250 people into trainee, Apprenticeships and work placements (upto 2012)
- Bring about change by increasing opportunities for women (11%) and disable people (3%) Minorities (15%)

Training was made integral part of the construction program to meet the current demand of the Olympic Park Construction while preparing for future material needs in major projects e.g. Cross rail, Stratford City, Thames limth and projects in Thames gateway.

For achieving this ODA worked with Learning and Skills Council (LSC), London Development Agency (LDA), five Host Boroughs, Job Centre plus and contractors. ODA followed 2-4-1 principle (two year planning, four year building and one year testing) in achieving its objectives and goals.

Job skills futures the ODA's Employment and Skill Strategy was published in 2008, suggesting that it would deliver 200 training interventions, work placements apprenticeship opportunities. The vast majority of training was delivered and on project rather than through classroom based sessions.

ODA published an integrated equality scheme in 2009 "Everyone" with following objectives:

- Inclusive Design

- Employment opportunities
- Business opportunities
- Community engagement
- Integration & Capability

There were extra efforts to create:

a) Positive employment, skills and economic legacy for UK after the Games
b) Create new Job opportunities
c) Create opportunities for continuing employment
d) Imposed skills & qualifications for local workforce
e) Better link between employers and Job seekers

The contracts entered into between ODA & various stake holders reflected the strategies, benchmarks, targets and requirements of "Job Skills Futures & EIES which helped DDA develop rigorous process to support, facilitate and measure the progress of all contractors.

LOCOG - Employment and Training in Non-construction sectors

LOCOG had to receive and train greater numbers, in advance of the event and into proper positions with limited training needs. The activities of LOCOG included , hosting of recruitment events, provide venues and staff aid source candidates, provide pre -employment training to match the requirements.

Employment and skill Managers were active link between the industry and candidates. ESM's were responsible for driving and capturing contractor demand

Olympic Park Construction / Skill forecast (2008-2011)

Phase	Period	Civil Engg	Building	Engg	Construction
1	Aug 2008 - Jan 2009	58%	24%	6%	12%
2	Feb 2009 - July 2009	45%	30%	13%	12%
3	Aug 2009 - Jan 2010	29%	36%	23%	10%
4	Feb 2010 - July 2010	20%	38%	32%	8%
5	Aug 2010 - Jan 2011	15%	56%	22%	7%
6	Feb 2011 - July 2011	42%	33%	12%	13%

Achievements

25864 people worked on the park for 5 or more days
3559 Training interventions provided against target of 2250
2397 Construction skills certification scheme cards awarded
671 supervisors provided with be spoke training

457 Apprentices experienced work against target of 350

Table Showing Park and Village Targets and Benchmark Workforce Data

Employee Category	Benchmark/Target Percentage of Workforce	Actual Percentage of Workforce on the Park	Actual Percentage of Workforce on the Village
Black, Asian and minority ethnic backgrounds	15%	21%	13%
Women	11%	4%	3%
Disabled people	3%	1.1%	0.9%
Local residents (Five Host Boroughs	10-15%	24%	28%
Previously Unemployed people	7%	13%	10%

Table Showing JSF Brokerage Targets and Benchmark Workforce Data

Employee Category	Benchmark/ Target Percentage of Workforce	Actual Percentage of Workforce
Black, Asian and minority ethnic backgrounds	15%	60%
Women	11%	17%
Disabled People	3%	6%
Local residents (5HBs)	10-15%	71%

Success of ODA Strategy :

a) Collaboration between competing contractors/firms
b) Women engaged in construction projects
c) High number of apprentice engaged
d) Active art reach programme - motivating to youth on construction sector
e) Attitude change
f) Diversity & Inclusion - Good representation of Diverse workforce - Gender, Race, Disability, Locals
g) Sustainable workforce for future projects.

Lessons Learnt:

a) Having a dedicated team with single point of contact was useful in achieving targeted training interventions which helped in satisfying contractors needs and ODA's aspirations & objectives
b) Coordination , partnership , collaboration and communication among various stakeholders was key to success
c) Flexibility of funding regimes helped in getting on the ground and delivery of ODA's objectives
d) Valid workforce data and ability to forecast trade and number requirements with regular monitoring of progress was critical
e) Making the links between equality, inclusion, employment and skills helped improving benchmarks and targets significally.

Applicability of Big Skills Model :

a) Infrastructure Projects including Smart Cities, Housing Complexes, Highways, Airports, Railways, Bridges , Roads and Ports.
b) Mass Skilling of youth for employability
c) Mass up skilling of workers for high end projects.
d) Mass Skilling for employability of Local / PWD/ Women/ Unpreviledged Groups.

Worsening Food Crisis
Further Hinders Global Productivity

Guo Yan-Qiang, He Zhi-Ling , Anita Tang

Abstract

More than 10 percent of the world population constantly live in hunger. The COVID-19 pandemic, climate change, and the war in Ukraine all contribute to the deepening of the already broken supply-chain problem. Not only is the world currently suffering from immediate food-security issues, but we should also expect harsh times ahead in securing global food supply.

China is continuing to improve its food security strategy to feed its 1.4 billion population, not an easy shoe to fill but not impossible to achieve with the cooperation of its people, introduction and execution of relevant policies, and implementation of agricultural innovation.

Feeding the current and future global population can only be possible through cooperation and collaboration from countries around the world.

The United Nations estimates that the world population will reach 9.8 billion in 2050, and 11.2 billion in 2100.[1]

The current world population is at 7.5 billion but 11.6 percent of it is undernourished, as indicated in the World Food Programme's live HungerMap (June 27, 2022).[2]

While countries and policymakers were trying to find ways to feed the existing and the growing world population and were yet to succeed, more problems surfaced, including the COVID-19 pandemic, climate-change induced natural disasters, and the war in Ukraine.

I. Broken Supply Chain

The COVID-19 pandemic in 2020 further intensified the global food-shortage issue when the global supply-chain was disrupted - countries preserving their own food sources limit their food exports.

Fires, floods, landslides, and droughts in different parts of the world, as a result of climate change, negatively impacted food supplies and the people's ability to pay for food.

The war in Ukraine started by Russia on February 24, 2022, made the world's uphill battle against hunger even more severe. Both Russia and Ukraine are big food suppliers to the global market - accounting for about one-third of the world's wheat exports, and being among the top five suppliers of barley, sunflowers, and maize[3] . These two countries' halting their food exports not only created shortage of food but further drove up food prices.

This broken supply chain reduced productivity, poorer countries fell deeper into food insecurity, elevated food prices pushed more people into an undernourished state, higher inflation in almost all the economies in the world might risk a worldwide recession, but for sure further hastened inequality, hurting lower income households in particular.

II.Immediate Negative Impacts in World Food Security

Many countries in Africa were already in a food crisis - as a result of natural disasters, COVID-19, and rising food prices (as indicated in Chart 1) - even before the war in Ukraine.

After the war started in February 2022, supply-chain disruption in many countries in East, West, Middle, and Southern Africa - which rely on Russia and Ukraine for a significant percentage of their wheat, fertilizer, or vegetable oils imports - are experiencing further increase in the already high food prices in the region.[3]

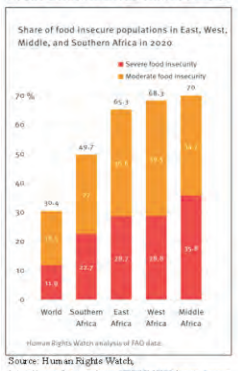
Asian countries, through geographically farther away, cannot escape the negative impact of the war because of their international-trade activities. New study lists published by CNBC in early April listed countries that are most vulnerable to rising prices (imports from Russia/Ukraine as a percentage of 2020 world imports)[4]:

• Fertilizer: Indonesia (more than 15%), Vietnam (more than 10%), Thailand (more than 10%), Malaysia (about 10%), India (more than 6%), Bangladesh (nearly 5%), Myanmar (about 3%), Sri Lanka (about 2%).

• Cereals from Russia: Pakistan (about 40%), Sri Lanka (more than 30%), Bangladesh (more than 20%), Vietnam (nearly 10%), Thailand (about 5%), Philippines (about 5%), Indonesia (less than 5%), Myanmar (less than 5%), Malaysia (less than 5%).

• Cereals from Ukraine: Pakistan (nearly 40%), Indonesia (more than 20%), Bangladesh (nearly 20%), Thailand (more than 10%), Myanmar (more than 10%), Sri Lanka (nearly 10%), Vietnam (less than 5%), Philippines (about 5%), Malaysia (about 5%).

Chart 1: Share of Food Insecure Populations In East, West, Middle, and Southern Africa, 2020



Source: Human Rights Watch,
https://www.hrw.org/news/2022/04/28/chronic/russia-war-continues-africa-food-crisis-looms

These are only immediate and direct short-term negative impacts to certain countries. Countries around the world are already dealing with fertilizer shortage, among others, which will have a lingering effect on future food supply.

III.Harsh Times Ahead to Secure Global Food Supply

The United Nations has warned that the war in Ukraine has helped to stoke a global food crisis that could last years if it goes unchecked. UN Secretary General António Guterres said shortages of grain and fertilizer caused by the war, warming temperatures and pandemic-driven supply problems threaten to "tip tens of millions of people over the edge into food insecurity."[5]

Apart from the crumpling food-supply chain, the Russian-Ukrainian war brought fertilizer shortage to the centerstage. Fertilizer shortage was an already acute issue before the war, and the war in Ukraine pushed the situation to an even more severe level. Fertilizer shortage, William White noted in his March 3, 2022 InvestorPlace article , "affects just about everyone as investors, consumers, and farmers deal with rising prices."

According to Morgan Stanley , Russia and Belarus provide some 40 percent of the world's exports of potash; Russia exports 11 percent of the world's urea and 48 percent of the ammonium nitrate. Russia and Ukraine together export 28 percent of fertilizers made from nitrogen, phosphorous, and potassium. Russia is strangling Ukrainian ports and so vessel shipments. Disruptions of shipments from Russia (although fertilizers are not subject to the Western sanctions, sales have been disrupted by measures taken against the Russian financial system, and that Moscow has also restricted exports5) and Ukraine has sent fertilizer prices skyrocketing. On top of disrupted supplies from these two countries, existing product stocks in the region are not getting out to the market because the Black Sea is closed. Adding to the burden, production costs of fertilizers - new stocks - went up due to soaring energy prices[5].

With the price of fertilizers shot up sharply, some farmers choose to rotate crops or use less nutrients, which means crops may not get as much nourishment and, in turn, yields could be compromised.

And in Ukraine, though with the proper agricultural material inputs, including fertilizers, many of the country's farmers are not tending to their fields because of the on-going war. In March, the United Nations warned that Ukraine may not be able to harvest crops, plant new ones or sustain livestock production . Ukraine alone exported more than US$27 billion in agricultural products to the world in 2021; any disruption in its food supply to the world, which is looking quite apparent at this point, is devastating.

Unless the war ends soon and Ukraine and Russia go back to their respective normal production and global-trade activities, the ripple effects in many spheres, particularly in global food supply, can be painful and long-lasting.

IV. How a Country can Better its Food Security - China as a Case Study

There is an ancient Chinese saying, "People are the most important to an emperor, and food is the most important to the people."

"In a turbulent post-coronavirus world," South China Morning Post pointed out, "ensuring food security has become an increasingly more crucial political priority for Beijing's new development strategy, which relies more on the domestic market and its consumers to resist external uncertainties."

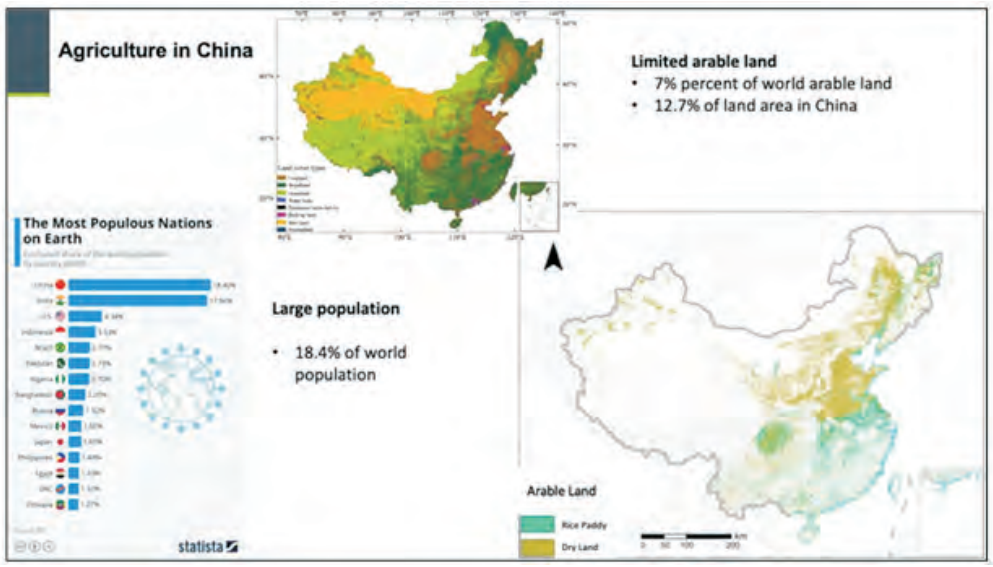
President Xi Jinping has said that the rice bowl of China must be firmly kept in Chinese hands, meaning China must ensure absolute safety in the supply of grains. And that "moderate imports" is a part of China's official strategy on food security.[9]

Official data does not show an immediate danger of food shortages in China, but risks lie in structural imbalances.9 China continues to take measures to ensure its food security strategy:

Protecting Arable Land

In 2019, China's total arable land amounted to 13 percent of the country's total area,

Diagram 1: Population and Arable Land in China



Source: Seeedstudio, https://www.seeedstudio.com/blog/2021/05/05/a-glance-of-agricultural-innovation-in-china

which translates into only 7 percent of the world's arable land. The amount of land dedicated to agriculture has fallen by more than 75,000 sq. km. from a decade ago due to the country's rapid urbanization[10].

“The increasing use of arable land for nonfarming purposes will affect national food security and must be taken into serious consideration," said Xia Zhuzhi, Associate Professor at the Rural Governance Research Center at Wuhan University. Cheng Guoqiang, Professor at the School of Agricultural Economics and Rural Development at Renmin University, said local governments should optimize the structure of rural land use and protect arable land, especially permanent basic farmland, and regulate the use of land for nonagricultural and nonfarming purposes.

On June 25, 2022, the Ministry of Natural Resources made an announcement that "it will take measures as hard as teeth to tackle the encroachment on arable land and uphold the central government's line of retaining at least 120 million hectares arable land.[11]

Devoting to its Climate Commitment

Climate change is one of the major factors threatening China's food security. Just in 2021 alone, heavy rainfall and flooding, extreme weather, and rising sea levels adversely affected crop productions in Henan, Hebei, China's northeastern provinces, and regions along the country's coastline[13].

Back in 2020, flooding in 27 southern provinces had damaged nearly three million hectares of crops as of July 10, according to the Ministry of Emergency Management. Research released by Chinese securities firm Shenwan Hongyuan estimated that the floods in China would reduce grain output by about 11.2 million tons in 2020, accounting for 1.69 percent of the country's total crop output in 2019.[14]

On October 28, 2021, China released a new national climate commitment. It aims to peak CO2 emissions before 2030 and achieve carbon neutrality before 2060 . Many Chinese provinces and localities have committed to climate goals as well. At least 23 provinces and cities have committed to peaking CO2 emissions before 2030 as part of China's Alliance of Pioneer Peaking Cities[16].

Promoting Agricultural Innovation

Agricultural innovation plays an important role in a society's sustainable development. Value-added methods in agriculture such as information technology, automation, and biotechnology all helping in improving agricultural management, achieving better yields, and creating bigger margin in agriculture. Be it data-based decision-making, or e-commerce to better manage the value chain and supply chain, the learning curve can be greatly shortened and optimized by combining traditional knowledge, creative solutions, and innovation.

The most recent innovation in Chinese agriculture is a push into organic agriculture. This rapid embrace of organic farming simultaneously serves multiple purposes, including food safety, health benefits, export opportunities, and, by providing price premiums for the produce of rural communities, the adoption of organic agriculture can help reduce the migration of rural workers to the cities.[18]

The successful implementation of seawater rice production, pioneered by the late agricultural scientist Yuan Longping (the father of hybrid rice), is making an impact. Yuan's crossbreed of high-yield rice and a form of wild rice which is more resistant to salt, produces a higher yield than standard varieties. His work is thought to have saved millions from hunger.[13]

Campaigns Against Food Waste

In 2018, the report on a study conducted by the Chinese Academy of Sciences and the World Wildlife Fund in 2015 of four Chinese cities (Beijing, Shanghai, Chengdu, and Lhasa) was released; it estimated that 17-18 million tons of food was being discarded annually by Chinese consumers, an amount that could feed 30 to 50 million people for a year.[19]

In July 2019, the city of Shanghai introduced strict regulations obliging individuals and companies to correctly recycle their food waste. Citizens faced fines as punishment for not complying, or their social credit-rating scores were lowered.

The Shanghai model has since been rolled out to other cities.[20]

In August 2020, President Xi Jinping highlighted that COVID-19 had "sounded the alarm" on food waste, adding that China had to "maintain a sense of crisis about food security." The nationwide "Clean Plate Campaign" was born. Not only could the campaign help reduce unnecessary wastage of food, but it might also help reduce the number of obese people in the country (in 2016, China overtook the U.S. to have the greatest number of obese people in the world).[20]

V. Conclusion

Different countries and regions have their own unique issues when facing food security. Whether involving natural resources, geography, climate, or financial resources, no one country has the same problems or solutions.

Every minute, 15 people in various parts of Asia and Africa die from starvation, but at the same time millions in developed Western countries die from unhealthy conditions caused by obesity.[21]

Global cooperation, knowledge and resource sharing can be powerful tools to help reduce food insecurity, or to better feed the current and the future world population.

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The United States And China, Competitors or Collaborators to Combat Climate Change?

Anita Tang

Abstract

China is the world's largest emitter of greenhouse gases, and the United States is the second largest.

The two countries once were at the forefront of environmental collaboration - as early as the 1980's. But their environmental partnership suffered a serious break when the Trump administration began setting tariffs and other trade barriers on China in January 2018, and the conflicts eventually turned into a full-blown U.S.-China trade war.

It should be of great interest for President Biden and President Xi to find common ground for the United States and China to work together - for their respective countries and to provide leadership to the world - and reinvigorated collaboration on the environmental front is a desirable notion.

This Paper examines what the United States and China are doing vis-à-vis their environmental commitments to the global community, potential areas of competition and collaboration.

A question is being brought to the foreground: "Will the world's two largest greenhouse-gas emitters work together in some ways to combat climate change?" The most recent development was that the two nations announced on November 11, 2021, at the UN's COP26 climate summit in Glasgow, Scotland, that they plan to work together to curb their emissions in an effort to fight climate change. We have yet to see the extent of this working relationship but it is certain that fighting climate change is a hard and long-term effort that demands determination and persistency.

The outlook, as I concluded this paper, is for the world to win the war - the war against climate change.

Climate Change Shocks - Right Here, Right Now

In 2021, just in the month of July alone, the disastrous wildfire destroyed the entire Lytton village in British Columbia, Canada. Over the border to Oregon and Washington in the U.S., a death toll of nearly 200 people was reported during the record-breaking heatwave. Across the Atlantic, flash floods hit Germany and Belgium with death toll rising to over 200. South to Africa, heavy rain flooded Lagos in Nigeria and paralyzed its entire economic activity. Some 5,700 miles away in Russia, flooding affected 99 settlements across its territory and had forced almost 4,000 people to evacuate their homes. South in Inner Mongolia, China, two reservoir dams failed after a period of heavy rainfall and thousands were affected by the resulting floods. Moving southeast to Henan province, flooding turned the streets in Zhengzhou to rivers, killed at least 57 with close-to-a-million people being removed from their homes. Heavy floods in India resulted in landslides which took away lives of some 125 people. Natural disasters also adversely affected people in Costa Rica, Saudi Arabia, Iran, Turkey, France, Italy, Austria, the Philippines, among others.

Climate change is right here impacting our normal life. We can see it and feel it.

Environmental Cooperation Led by U.S.-China Partnership

China is the world's largest emitter of greenhouse gases (GHG), the United States is the second largest.

The two countries once had been at the forefront of environmental collaboration. Their partnership on environmental protection started as early as the 1980's[1]. In 2014, the United States and China made a joint announcement on their intent to reduce emissions with their respective climate targets, which helped build international momentum. By December 2015, 180 countries responsible for nearly 95 percent of global emissions announced their climate targets. They signed the Paris Climate Accord (Paris Agreement) which replaced the 2005 Kyoto Protocol.

However, the Trump presidency moved the United States further away from its allies, from its alliances on climate and energy with China, and alienated it from ongoing multilateral climate negotiations. On November 4, 2020, the U.S. withdrew from the Paris Climate Accord. U.S. emissions declined more slowly during President Trump's term than President Obama's. Other advanced economies like the EU and Japan have reduced emissions faster [2].

The United States may see China as an adversary or a competitor on different fronts, but there is a glimmer of hope that the Biden administration may help the two nations again find common ground as collaborators to address climate change.

Deep Decarbonization is Needed to Tackle Climate Change

In a January 28, 2020, article published by the Yale School of the Environment, David G. Victor asserted the urgency of the need for a realistic blueprint to wean our economies off carbon emissions:[3]

"Emissions are now rising at about 1 to 2 percent annually, even though a new UN study shows they must tumble nearly 8 percent per year to be consistent with holding warming to 1.5°C.

"No major economy has ever cut emissions of warming gases that quickly; it's not practical to make such cuts globally on the time frame of industrial and agricultural systems that usually don't change quickly.

"The planet will blow through the 1.5°C goal and through 2°C as well. Even with a big effort, we may be on track for 3°C or more - levels of warming that scientists say will have ruinous consequences."

Though close to 200 countries are involved in the encouraging framework of the Paris Agreement, Victor pointed out that "Global diplomacy and global agreements will operate too slowly and too cautiously to address the climate crisis. Global agreements have a role to play, but they will largely be followers rather than leaders."
So, where does the world stand now on sustainability?

The 2020 Environment Performance Index (EPI) ranked Denmark on top. Other nations in the top tier included Luxembourg, Switzerland, the U.K., and France, while the U.S. is in the 24th spot, and China, 120th.[4]

"Accelerating the Low Carbon Transition," a report published by the Brookings Institution in November 2019, argued that getting serious about decarbonization requires a new approach to industrial policy - one that is organized sector-by-sector and coordinated internationally to create progressively larger markets and stronger incentives for decarbonized industries.[5]

China Puts its Climate Commitment on The Table

Despite COVID-19 pandemic-related slowdown, global emissions are still on the rise.

On September 23, 2020, Chinese President Xi Jinping told the UN General Assembly that China aims to have CO2 emission peaked before 2030 and to achieve carbon neutrality before 2060.

Beijing's commitment prompted neighboring countries to follow suit, with Japan committing to net-zero greenhouse-gas emissions and South Korea to carbon neutrality by 2050. According to Greenpeace, these three Asian economies together accounted for one-third of all global carbon emission in 2018.

Beijing is sending a clear and powerful message: it is playing by the rules of the Paris Agreement, which revolve around independent national commitments. It has not asked for a quid pro quo from other countries. It is simply taking the lead.

Though some observers question China's ability to quit its dependency on coal and its ability to quickly transition to renewable energy to meet its emission time-commitment, others are hopeful that China can make it happen, especially when the cost of renewables is coming down fast.

Christine Loh, chief development strategist at the Institute for the Environment at Hong Kong University of Science and Technology, believes that China's decarbonization target "did not come out of the blue." Given the scale of China's 2060 pledge, Loh believes that China has not only been planning for a decarbonization revolution, but is responding to fear about possible impact on China, including severe flooding.[7]

The U.S. Plan is about A Clean Energy Revolution

Combatting climate change was a part of the Biden presidential campaign. As soon as he took office in January 2021, President Biden unveiled his environmental plans - Green New Deal-like initiative aimed at putting climate change at the center of the country's domestic, national security and foreign policy - and the U.S. formally rejoined the Paris Agreement on February 19, 2021.

“Right now we have to act and act fast. We're late in the game here," President Biden said at the White House on June 30, 2021, during a meeting with governors from western states

facing a record-breaking heat wave. "The truth is we're playing catch up. This is an area that has been under resourced, but that's going to change if we have anything to do with it."[8]

The infrastructure plan Biden proposed will cost around US$2 trillion. This covers investments in infrastructure, an American-based energy-efficient automobile industry, increased public transportation options, a sustainable power sector, weatherized buildings and housing, scientific innovations, climate-smart agriculture and conservation, and efforts to promote environmental justice.[9]

<u>The U.S. Plan for Climate Change</u>

President Biden pledged to cut America's emissions in half by 2030, eliminate fossil-fuel emissions from power plants by 2035 and zero out all greenhouse-gas emissions by midcentury.[10]

The Biden administration addresses its climate-change plan in the following areas:[11]

1.Ensure the U.S. achieves a 100 percent clean-energy economy and reaches net-zero emissions no later than 2050
2.Build a stronger, more resilient nation
3.Rally the rest of the world to meet the threat of climate change
4.Stand up to the abuse of power by polluters who disproportionately harm communities of color and low-income communities
5.Fulfill the U.S.' obligation to workers and communities who powered the country's industrial revolution and subsequent decades of economic growth

Competition or Collaboration?

Underlying the confrontations on combatting climate change (between nations and within nations) was the assumption that tackling climate change would be costly, and negotiations were mostly about how these costs should be distributed. China and many developing countries argued that industrialized nations bore "historical responsibility" to lead on reducing the carbon emissions that had fueled their prosperity.[12]

Stephen Minas, in his May 2, 2021, article, pointed out that "these arguments persist, but the underlying cost-benefit analysis in many countries has shifted radically." He further noted that "for a growing number of countries, reducing emissions is now about transforming economies in order to prosper in the carbon-constrained future."[13]

For such a transformation, it involves education, regulation, innovation, execution, and transition. While there needs to be some adjustments in personal habits and possibly lifestyle, the bulk of the change would be to incorporate more energy-efficient hardware and software into our daily life, which has a lot to do with business enterprises.

To reach carbon neutrality, countries have to lower their greenhouse-gas emissions and find ways to capture carbon, or use carbon credits to get to carbon-neutral status. They cannot do it alone.

Competition

While China and the United States may work together in this environmental front, there are, however, areas for competition that their respective government have distinctively announced. I am raising here cases in transportation and electricity production.

Transportation

Whether it is movement of people or goods, and whether it is through ground, air, or ocean, we need to bring about energy efficiency in transportation.

Developing electric vehicles (EV) and putting them on the road can be high up on many countries' agenda.

China is ahead of the curve in EV for many reasons. As noted by Jack Perkowski, "China has no other choice." Perkowski offered his analysis on the three fundamental paths China may follow: "First, it can choose to live with a rapidly growing number of ICE (internal combustion engine) powered vehicles on its roads, with all that implies as far as air pollution and energy independence. Second, the government can restrict the transportation choices of its citizens in an effort to balance environmental concerns. Or third, the country can embrace EV technologies that enable its citizens to have their cars without jeopardizing air quality in its cities."[13]

The United States is not contented to be just another player in the big EV market. On May 18, 2021, President Biden said at Ford Motor's Rouge Electric Vehicle Center in Dearborn, Michigan:[14]
"Look, the future of the auto industry is electric. There's no turning back.

"The only question is whether we'll lead the race or fall behind.
"Right now, China is leading in this race, make no bones about it; they will not win this race. We can't let them."
Competition in the EV market to produce good or better-value EVs should be welcomed by consumers all over the world. As long as such competition is conducted in free market trade policy instead of protectionist trade policy, it should benefit all.

Electricity Production

In 2019, 63.3 percent of global electricity came from fossil fuels15. In the U.S., approximately 62 percent of electricity came from burning fossil fuels, mostly coal and natural gas16, and in China, 66.9 percent of electricity came from fossil fuels in which 62.2 percent was from coal[17].

Michael Standaert voiced his concerns on China's coal spree: "China is building large numbers of coal-fired power plants to drive its post-pandemic economy. The government has promised a CO2 emissions peak by 2030, but the new coal binge jeopardizes both China's decarbonization plans and global efforts to tackle climate change."[18]

Institute for Energy Research (IER) provided some insights in this area:[19]
"China is allowing coal power plants to be built until around 2030 when China will be richer and replacement technologies will have advanced and their costs will be lower.

"Five years ago, Chinese companies began upgrading their plants to trap more of the small particulates that generate smog, and to produce more electricity from every ton of coal they burn.

"Chinese companies also believe that technology breakthroughs in areas such as carbon capture and sequestration, which traps and stores the greenhouse gases emitted when coal is burned, will help to achieve carbon neutrality."

IER also pointed out that China is investing heavily in oil-refining capacity and is about to unseat the United States as the world leader in petroleum refining, a position the United States has held for over a century.

Collaboration

Besides lowering greenhouse-gas emissions, finding ways to capture carbon are also important to help our planet reach carbon neutrality.

These are areas where neither the U.S. nor China are clear leaders, and other countries in the world are in the race - which should open up avenues for collaboration and cooperation. Different forms of carbon sequestration: carbon capture and storage (geologic) and carbon farming (biologic), may fit into this area.

Carbon Capture and Storage

Carbon capture and storage (CCS) could potentially capture around 90 percent of the CO2 emitted when fossil fuels such as coal are used. The CO2 would then be transported and stored safely underground so it cannot contribute to climate change.[20]

CO2 capture technology has been in used since the 1920's for separating CO2 sometimes found in natural gas reservoirs from the saleable methane gas. This existing technology started being applied to CCS in the 1970's.[21]

ReportLinker profiled the leading companies operating within the carbon-capture-and-storage market. Of these top 20 companies named, 11 are located in North America, six in Europe, two in Asia, and one in the Middle East.[22]

Decades of research has made CCS technically feasible, but it is both incredibly complex and wildly expensive. Nevertheless, the fossil-fuel industry continues to chase after carbon capture. In February 2021, ExxonMobil said that it is investing US$3 billion over the next five years on projects to lower emissions, including 20 carbon-capture projects around the world.[23]

Molly Taft summarized the current situation: "On paper, CCS sounds like the solution to all our problems. If we could just suck the carbon dioxide emitted by burning fossil fuels and put it somewhere else, we could cut warming without shifting away from old methods of generating energy. In practice, though, the results have been less than promising and failed to scale at anywhere near the levels needed to avert catastrophic climate change."[24]

If the world is determined to use CCS as a way to help solve the climate problem under a definitive timeframe, it is wise and makes sense for the world to pull resources together to collaborate and cooperate on this complex and expensive front.

What's Next?

While countries work to reduce emissions to transform their respective economies, will the world's two largest emitters of greenhouse gases work together on this environmental front?

Aside from areas mentioned in this Paper, will the United States and China, and possibly other countries and regions in the world, collaborate on carbon farming as an avenue to save our environment?

For the United States and China, there are many battles. One wins some and loses some. The key is for the world to win the war - the war against climate change.

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Report of Round Table on Productive Equity II

Dr. Sunil ABROL, Prof. Michael SHEPHERD, Ms. Anta TANG

Background

In May 2019 Brookings Institution and the Chumir Foundation for Ethics in Leadership published a report titled *Productive Equity: Technology and the Twin Challenges of Reviving Productivity and Reducing Inequality.* This report (PE I) shows both a decline in productivity and an increase in inequality.[1]

A second study (PE II) has been proposed by the Chumir Foundation in conjunction with the World Academy of Productivity Science (WAPS) to examine the role of technology in these phenomena. A series of virtual round tables has been planned in order to orient this second study and to determine a direction to be taken and questions to be answered.

The first such virtual round table was held on July 27/28, 2021. As this will be a global study, technologists from the Asia time zones and the Pacific time zones participated. A second round table will include technologists from the Eastern and Central, U.K. and Europe, and Africa time zones.

Prior to the round table, participants were provided with a two-page brief about the project with a link to the PE I report and a fact sheet from the PE I report summarizing some of the findings regarding productivity and investment, etc.

The round table was held on Zoom and, with permission from the participants, the round table was recorded. The names of the participants can be found in Appendix A. Their anonymized comments are included in Appendix B. Common themes were extracted from these comments and a matrix of the common themes addressed by the participants is presented in Appendix C.

Common Themes

The following common themes were extracted from the comments of the participants.

[1]This report was prepared by the WAPS organizers, Appendix A.

Culture of Technologists: Culture was brought up a number of times, particularly with respect to work ethic and direction. The culture of technologists was brought up but not referred to as a "culture". Technologists do not necessarily develop technologies with the larger economic picture in mind, nor on how people will use the technology. They tend to be narrowly focussed on the technology itself and often do not consider if the technology will scale.

Digital Transformation: This had multiple parts, two of which are notably disruption in the workforce and growing inequalities.

Transition to new technologies is often not well planned. Such transitions often do not take into account the skills and knowledge of the current workforce and as a result there is disruption in the workforce. This leads to growing inequalities with positive feedback loops that favor entrenched interests at the expense of true innovation. The rich gets richer and the poor gets poorer, and the middle is being hollowed out.

Scale: Technology at scale is not the same as economies of scale. Technology at scale is taking technology and increasing its spread and use over a larger base. However, technology is not usually developed with being scaled in mind. As a result, many technologies when scaling ups do not produce the desired effects and productivity does not reach its full potential.

Government Policies: Government policies have a huge effect on productivity and technology. Policies effect everything from marker power, to funding of innovation, to intellectual property.

Productivity: Productivity is not driven just by technology. Productivity needs more than just technology but human skills as most innovation is incremental, building on a base of products and skills.

Key Points to Consider for the PE II Study

Productivity: The PE I report was based on data prior to 2014 and GDP annual growth up to 2017. These data show a decline in both metrics. More recent data *(US Labour Productivity Growth, 1949 - 2021 | CEIC Data, The coming productivity boom | MIT Technology Review)* are projecting a significant increase in labor productivity, primarily due to technology. These data should be examined for the impact on inequality.

Labor Productivity Formula: The current formula for Labor Productivity is GDP divided by hours of labor. However, the growth in the intangible economy may require that this formula be revisited. The labor hours for intangible products and services are invested up front and the longer these intangibles stay in the market place, the greater the GDP but the lower the labor hours, resulting in an increased labor productivity measure but with fewer labor hours (greater inequality).

Quality Data: Quantification of quality data is critical to measuring the impact of various factors on Productivity.

Summary

This first round table was stimulating, and the discussion generated further valuable insights. A second round table with perhaps slightly refined questions presented to the participants should be equally productive.

WAPS proposes to carry out series of Round Tables with experts across sectors and countries to get wider perspective of variables and parameters that contribute to Productivity in the context of Technology Development and Deployment.

Appendix A

Round Table Participants, July 27/28, 2021

Invited Participants, in no particular order:

- Mr. David Kasik, U.S.A.
- Mr. Daniel Yeo, Singapore
- Prof. Danny Tsang, China
- Mr. Leon Bian, U.S.A.
- Dr Andrew Csinger, Canada
- Mr. Allen Huo, Taiwan
- Mr. Mohan Das Pai, India

Also attending:
- Joel Bell (Chumir Foundation), U.S.A.
- Sunil Abrol (WAPS, Project Lead), India
- Anita Tang (WAPS), U.S.A. and China
- Michael Shepherd (WAPS), Canada

Appendix B
Participants' Discussion Points

Participant A
- Technology and innovation contribute to higher productivity growth.
- In U.S.A. labor productivity has increased by 5.4% in Q1 2021.
- Erik Brynjolfsson and Georgios Petropoulos wrote in a June 10, 2021, MIT Review: "There's reason to believe that this is (5.4% labor productivity growth) not just a blip, but rather a harbinger of better times ahead: a productivity surge that will match or surpass the boom times of the 1990s." They based their optimism on three factors:

1. Technological breakthroughs during the past decade such as advancements of AI/ML, the ever-lowering cost of computing power, and discoveries in medical treatments like mRNA, among others.
2. The compressed restructuring timetable for digital innovations - to remote working because of covid-19.
3. An economy trending towards full capacity.

- Technology alone is not enough for increasing productivity, it needs to be clubbed with business processes, human skills, and other intangibles.
- Productive Equity I is partly based on productivity growth statistics in previous years, with the new trend, we may need to revisit some of the assumptions and conclusions about technology and productivity growth in this second phase of the study.
- Concentration of market power raises issues for competitors, consumers, and the labor market. Dominant companies take bigger shares of total benefit in the areas where they compete.
- Does technology cause a concentration of market power? My view is "no." Market power derives from many non-technological factors:

1. There are clear incentives for a "winner-takes-all" approach - the market usually rewards firms that best meet customer needs; so, investors and co-founders/top executives do their best to gain market share.
2. Public policies enabled many dominant players to secure their positions (some through M&A) within their markets and expand into other markets. Once a firm achieves a dominant position, its dominance becomes a barrier to other firms wanting to enter that arena or engage in similar activities.
   As remedy, maybe we should seriously consider breaking up some companies as too many of them are just too big.

- There is a need for public policy to encourage cooperation between education, technology development, industry, and competition; and reform tax codes.
- Technology enables improve quality of life and reinventing work.

Participant B
- Productivity is a combination of human factor and technology. It is human beings' willingness to do things, the

ability of the individuals, the ideas and creativity which help a company innovate.

- There is a need for integration of technology, human factor, culture, and processes. Human factor and culture - self motivation, norm, family upbringing, peer pressure, etc. can have big impacts on innovation and technology; this is particularly true in some Asian economies.
- Integration of human and technology is about linking the disconnected parts together. Productivity can be increased by applying the right technology and assigning the right job to the right people.

Participant C

Point 1

- Inequity between those empowered by the new technology and those who are disenfranchised by new tech
- This leads to income disparity
- How do we take advantage of the skill sets of these displaced persons?

Point 2

- Technologists make it difficult for others to transition to new technologies
- Technologists tend to ignore existing infrastructure and world
- They design and build things not easy to implement in a meaningful way

" Technologists do not play nice with others

Point 3

- Challenge to accommodate for scale
- Scale but keep existing customer base happy
- Technologists do not build for scale
- Benefits of new tech often not realized because it is not designed for scale
- Transition to new technology not well planned:
  - o Benefits not realized
  - o People displaced

Point 4

- Need good data

Participant D

- During the last decade U.S. productivity has increased from 3% to 9%
- Who is getting the benefit and value add of Technology? Economy, Industry, People
- People are most affected by technology
- Productivity is stagnating
- While prices are going down, value add is going up
- Automation is helping in improving efficiency
- Capital gets maximum benefits of technology
- Big Tech not good for society
- Labor cost coming down year after year
- Global monopolies control Big Tech

Participant E

- Technology is driver of productivity
- Slow adoption of technology leading to low productivity
- Public policy plays important role in adoption and deployment of technology
- Social acceptance of technology a barrier

Participant F

- Changes are needed in the way innovation is funded

- Current model is a positive feedback loop that favors entrenched interests at the expense of true innovation
- Change from funding at very grass roots of innovation to funding aggregation of large companies (super clusters)
- Metric seems to be more at number of dollars than actual innovation
- Large companies now do less in-house innovation and more acquisitions (scale issue)
- Government becoming more like large venture capital funds
- Moving to scale is still a problem
- Perhaps micro-funding might help with grassroots funding

Participant G

- Some countries benefit from technology while others not as much.
- Developing countries have the bare minimum facilities and have much to gain in technology innovation.
- Developed countries, when adopting new technology, have redundancy issues to resolve due to existing processes, people, and system.
- In terms of distribution of benefits, the creation of wealth by corporations is to monetarize innovation, it is up to the owners of the Big Tech companies to redistribute the wealth.
- Government also plays a role in policies impacting the redistribution.
- Innovation, technology, and advancement are all good, it is about:

1. How do you monetarize it?
2. How then to redistribute the profit or benefits to the masses
   If 1 and 2 are doable, people will see the benefits of the advancement of technology.

Appendix C
Matrix of Common Themes and Participants' Comments

Participant	Culture	Disruption in Workforce	Growing Inequalities	Scale	Government Policies	Productivity needs tech, human skills etc.
P1			X		X	X
P2	X	X	X	X		X
P3	X					X
P4	X	X	X	X		
P5			X			
P6					X	
P7			X		X	

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