What role for science if poverty reduction is wicked & impure?

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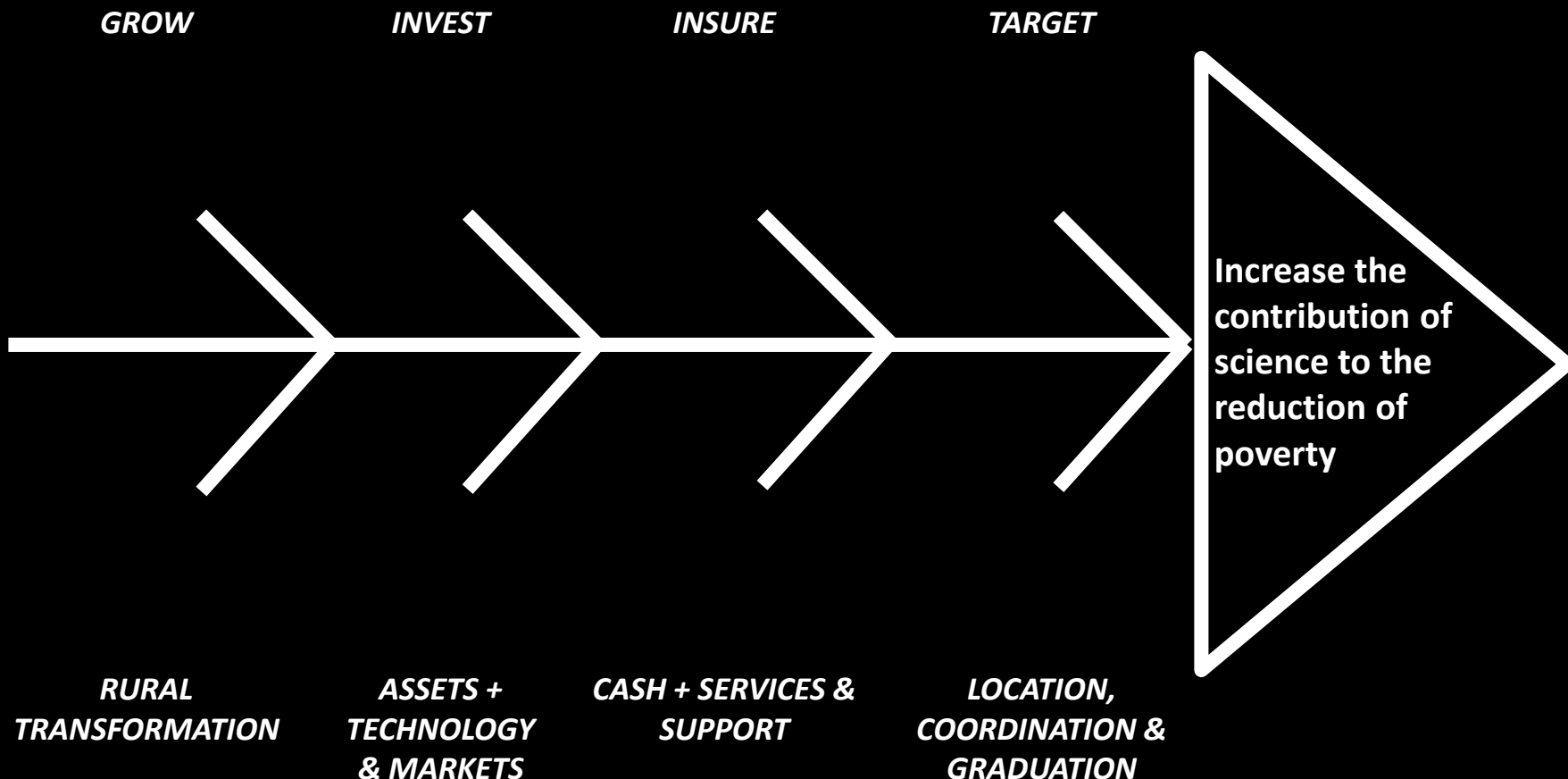DST-NRF Centre of Excellence in Food Security

- "Any statement of policy to reduce poverty contains an implicit if not explicit explanation of its cause. Any explanation of poverty contains an implicit prescription for policy. Any conceptualisation of poverty contains an implicit explanation of the phenomenon."
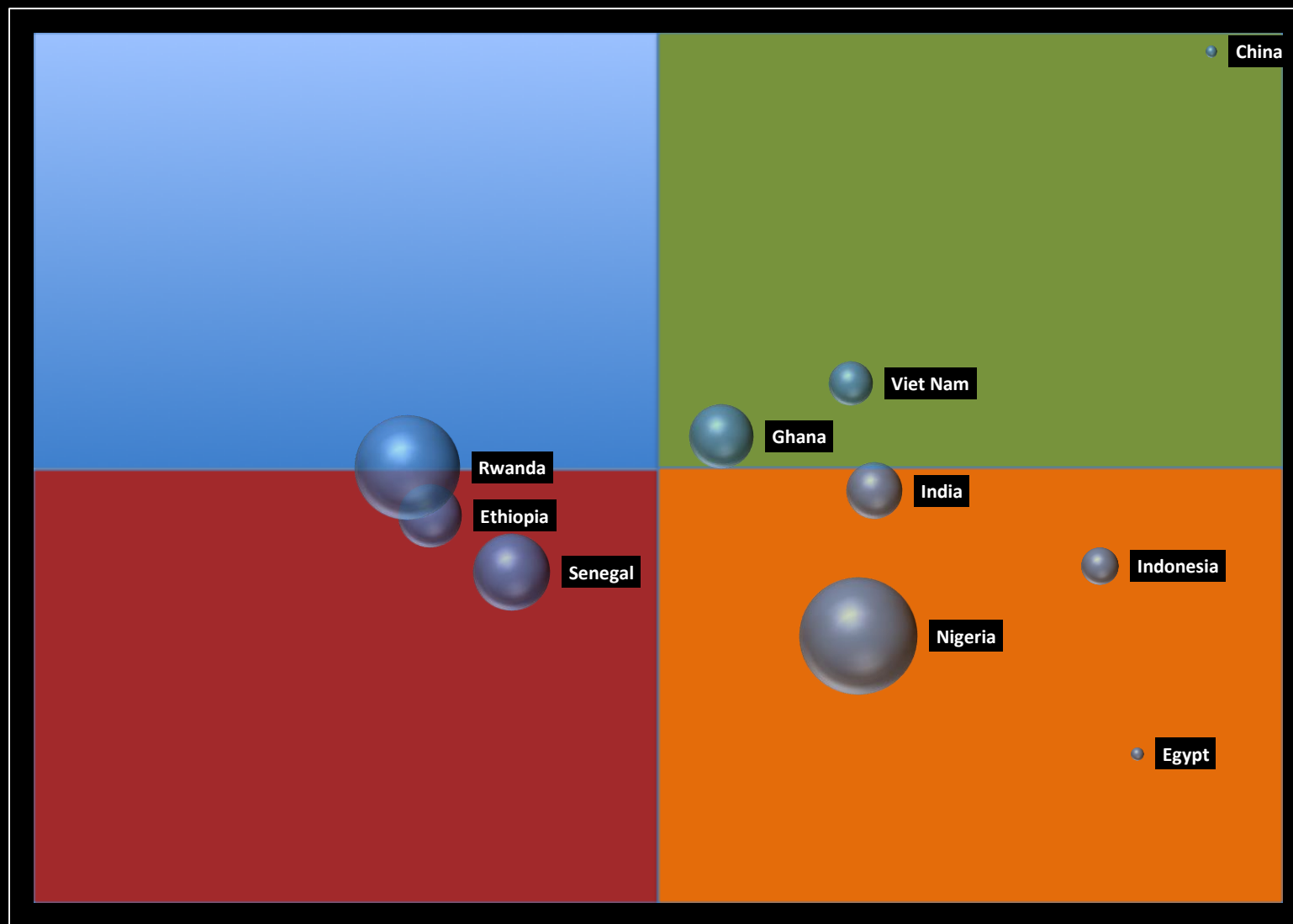(Townsend, 1979: 64)

What is the link to food insecurity?

- Extreme food insecurity is highly correlated with extreme poverty
- Food security is a form of deprivation and an outcome of vulnerability
- As with other forms of deprivation such as poverty, it is multi-dimensional, its intensity and duration varies, it has an absolute, subjective and relative nature
- There is culpability for its production, and duty in its reduction

What is food, what is food security?

- Food is any substance, whether processed, semi-processed or raw, which is intended for human consumption … and any substance which has been used in the manufacture, preparation or treatment of "food" (Codex Alimentarius 1963)

- Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (World Food Summit, 1996)

What is food to an economist?

- A commodity, predominantly privately produced and purchased, one component of food security, along with other components such as food safety, social protection and food price stability
- Subject to the primary principle
- Rivalrous and exclusive: the consumption of food by one person reduces its availability for others; and that it is possible for some to be excluded from access to food by others

Micro-economics of food security

- Processes subject to market imperfections that contain significant positive and negative externalities
- Food availability, access and stability rely upon food value chains characterised by power asymmetries
- Resources for food production require public goods under the stewardship of food producers
- Price signals that could bring about market efficiencies operate poorly in the context of externalities
- Price signals conceal direct costs and the opportunity costs of mismanagement

A public good?

- The consumption of food security by one actor does not reduce its availability for others; and it is not always possible for some to be excluded from being food secure by others

- Society deem some private goods as being *de facto* public in their consumption

- The signatories to Article 25 of the Universal Declaration of Human Rights and the Article 11 of the International Covenant on Economic, Social and Cultural Rights have deemed food security to be universal, indivisible and interdependent

- Food security is then a national and a global public good (in the eyes of society)

But…

- Food security is also the joint product of private and public action
- It is thus an impure public good
- It is therefore subject to collective action problems
- In collective action, stakeholders, faced with a common concern, will need to find ways of acting together with their different interests in mind
- Institutions (formal and informal structures of living together) provide the context and systems of rules within which collective action takes place
- These institutions require collective capabilities in to achieve positive action

III. GROVER'S ALGORITHM FOR MULTIPLE NEEDLES IN A HAYSTACK

So far I have worked with a function which maps $\{0,1\}^n \to \{0,1\}$ and has only one marked item. But more generally we can design our Grovers algorithm to work with a function $\{0,1,\ldots,N-1\} \to \{0,1\}$ which is 0 on $N-M$ on this domain and is 1 on the rest of the M points of this domain. The goal then will be to find a single one of the inputs x such that $f(x) = 1$. For now we will assume that we know M. Let S be the set of x such that $f(x) = 1$. Then we can define the states

$$|x_0\rangle = \frac{1}{\sqrt{M}} \sum_{x \in S} |x\rangle \tag{41}$$

and

$$|\phi' = \frac{1}{\sqrt{N-M}} \sum_{x \notin S} |x\rangle \tag{42}$$

and again produce a Grover's iterate which rotates on this space. The argument is nearly identical, so I will not repeat it. The important point, though, is that the state will rotate by an angle satisfying

$$\sin \theta = \frac{2\sqrt{M(N-M)}}{N} \tag{43}$$

$$r_k = \sum_{x_0 \in \{0,1\}^n} |||\phi_{x_0}^k\rangle - |\phi^k\rangle||^2 \tag{17}$$

is small unless k is large enough. Then we will show that this implies that when this quantity is small there is no way to identify the x_0 with high probability. Why do we choose $|\phi^k\rangle$? Well this is the state that would exist if no oracle calls were made, so measuring our distance from this state is measuring how much effect the oracle is having.

So first we want to bound r_k. To do this we show that $r_k \leq 4k^2$. This is clearly true for $k = 0$. We proceed inductively. First we use the fact that U_{k+1} is unitary:

$$|||\phi_{x_0}^{k+1}\rangle - |\phi^{k+1}\rangle||^2 = ||U_{k+1}V_f|\phi_{x_0}^k\rangle - U_{k+1}|\phi^k\rangle||^2 = ||V_f|\phi_{x_0}^k\rangle - |\phi^k\rangle||^2 \tag{18}$$

The fact that this expression is equal is a consequence of the fact that the $|\phi_{x_0}^k\rangle$ and $|\phi^k\rangle$ states cannot be made more orthogonal by a unitary rotation. The only operator which can make them more orthogonal is V_f. Now we reexpress this as

$$|||\phi_{x_0}^{k+1}\rangle - |\phi^{k+1}\rangle||^2 = ||V_f(|\phi_{x_0}^k\rangle - |\phi^k\rangle) + (V_f - I)|\phi^k\rangle||^2 \tag{19}$$

Next use the inequality $|||a\rangle + |b\rangle||^2 \leq |||a\rangle||^2 + |||b\rangle||^2 + 2|||a\rangle||\ |||b\rangle||$ to obtain

$$|||\phi_{x_0}^{k+1}\rangle - |\phi^{k+1}\rangle||^2 \leq ||V_f(|\phi_{x_0}^k\rangle - |\phi^k\rangle)||^2 + ||(V_f - I)|\phi^k\rangle||^2 + 2||V_f(|\phi_{x_0}^k\rangle - |\phi^k\rangle)||\ ||(V_f - I)|\phi^k\rangle|| \tag{20}$$

Since V_f is unitary,

$$|||\phi_{x_0}^{k+1}\rangle - |\phi^{k+1}\rangle||^2 \leq ||(|\phi_{x_0}^k\rangle - |\phi^k\rangle)||^2 + ||(V_f - I)|\phi^k\rangle||^2 + 2||(|\phi_{x_0}^k\rangle - |\phi^k\rangle)||\ ||(V_f - I)|\phi^k\rangle|| \tag{21}$$

Now $V_f - I = -2|x_0\rangle\langle x_0|$, so this becomes

$$|||\phi_{x_0}^{k+1}\rangle - |\phi^{k+1}\rangle||^2 \leq ||(|\phi_{x_0}^k\rangle - |\phi^k\rangle)||^2 + ||-2|x_0\rangle\langle x_0||\phi^k\rangle||^2 + 2||(|\phi_{x_0}^k\rangle - |\phi^k\rangle)||\ ||-2|x_0\rangle\langle x_0|\phi^k\rangle|| \tag{22}$$

or

$$|||\phi_{x_0}^{k+1}\rangle - |\phi^{k+1}\rangle||^2 \leq ||(|\phi_{x_0}^k\rangle - |\phi^k\rangle)||^2 + 4||\langle x_0|\phi^k\rangle|x_0\rangle||^2 + 4||(|\phi_{x_0}^k\rangle - |\phi^k\rangle)||\ ||\langle x_0|\phi^k\rangle|x_0\rangle|| \tag{23}$$

Summing this over x_0 we obtain

$$r_{k+1} \leq r_k + \sum_{x_0 \in \{0,1\}^n} \left(4||\langle x_0|\phi^k\rangle|x_0\rangle||^2 + 4||(|\phi_{x_0}^k\rangle - |\phi^k\rangle)||\ ||\langle x_0|\phi^k\rangle|x_0\rangle||\right) \tag{24}$$

Wicked

- No definitive formulation of the problem
- No stopping rule: a 'solution' is reached when money or time runs out
- A continuum of good to bad solutions
- No test as to the quality or durability of the solution
- No enumerable set of solutions and no set of permissible options
- Problems are potentially unique
- Problems may be symptoms of other problems
- Multiple explanations of problems are possible
- Attempts to solve problems count
- Aspirant solvers of problems are culpable for their solutions
- Time is running out
- Those who are causing the problem are also seeking to provide a solution
- A central authority to resolve the problem is weak or non-existent

(

(Rittel & Webber, 1973; Ackoff, 1997; Horn & Weber, 2007; Ison, 1997; Saaty & Kearns, 1985)

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Collective action problems

- Problems of coordination
- Problems of co-operation
- Problems of finding & keeping agreements
- Problems of inequality
- Problems of unstable solutions
- Problems of fundamental uncertainty about causes & consequences
- Problems of bounded rationality

Policy steps for reducing food insecurity

- Identifying the actors involved, including the duty-bearers, rights-holders and marginalised; convening these actors in some cases having first constituted them as agents; seeking a shared understanding of the problems and solutions being proposed, recognising when a solution may result in non-cooperation or contestation

- Selecting solutions from the continuum of good to bad; identifying who will benefit, including free riders, and who may bear costs without garnering any benefits

- Establishing which problems are symptoms of which other problems, or are problems arising from previous attempts to find solutions. Dealing with any unresolved culpabilities that remain from these attempts

- Listing multiple narratives and explanations of problems, identifying for whom the explanation holds, and the implications of this

- Partnering to establish processes, procedures and actions, and assigning responsibilities, including that of a regulator who will provide oversight and enforce stopping rules

What to do next?

- Agreeing on ways to check and report on the anticipated and unanticipated outcomes of the solution (including those affecting common property resources), and how these checks will evolve over time

- Identifying strategies to respond to these monitoring and evaluation activities in order to adjust the interventions

- Finding reflexive processes to regularly revisit the problem, the solution, the actors and the outcomes. Establishing a credible ombudsman to address contestations

- Identifying strategies to facilitate the transferability of solutions to new problems that while unique, are familiar

- Accepting and assigning duties and culpabilities for the provision of food, food security and nutrition, including the positive and negative externalities that follow, and include mechanisms for recourse, oversight and insurance