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Conference on New Directions for Smallholder Agriculture
24-25 January 2011, Rome, IFAD HQ

On Being a Smallholder

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Dinner Speech

On Being a Smallholder [1]

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Paper presented at the IFAD Conference on New Directions for Smallholder Agriculture
24-25 January, 2011

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Being a smallholder is a relevant term. Having less than two hectares (ha) is usually regarded as a smallholding in a developing country. 80 percent of all African farms (33 million farms) fall in this category. But in many parts of Latin America a small, predominantly subsistence farm is ten ha. Bangladeshis would regard this as a large commercial farm. Clearly 'smallness' is a generic term depending on the resources of the holding, not only the land but the labour, skills, finances and technology available. Irrigated rice farmers can produce high yields with two to three crops a year, consuming and selling their harvest even though the farm may be much less than two ha in size. In all continents, farms of less than one ha and with few resources are usually unable to produce a surplus for sale and cannot provide enough work or substance for the family. Such 'marginal' farms in India comprise 62 percent of all holdings, and occupy 17 percent of the farmed land.[i] As Prabhu Pingali reminds us, however, the Chinese agricultural revolution was brought about by very small smallholders, with only a *mu* of land, just 1/15th of a hectare.[ii]

Very approximately there are 400 to 500 million small farms, i.e. under two ha, in the world. This implies that some two billion people are dependent on smallholding for their livelihoods – a third of the world's population. The great majority of smallholdings, nearly 90 percent are in Asia.

Despite the diversity of smallholdings, three facts are not in dispute:

First, the size of land holdings is falling in the developing world, with the fastest decline in Africa.[iii] Average farm holdings for the continents of Asia and Africa are, at the latest 1990 census, 1.5 ha. Despite assertions to the contrary, there is not much extra arable land available for cultivation and population increase continues to divide and divide land holdings. Smallholders are getting more numerous and smaller.

Second, land and water are deteriorating. According to the semi-quantitative *Global Assessment of Soil Degradation (GLASOD)* about 300 million hectares (mha), or five percent of the formerly usable land in developing countries, has been lost by severe soil degradation up to the present day i.e. more than has been brought into production.[iv] The current rate of loss is not less than five mha per year.[v] Water, like land, is similarly in short supply and for similar reasons – over-use, inefficient use and degradation through pollution.[vi] Many river basins in the world do not have enough water to meet all the demands: about a fifth of the world's people, more than 1.2 billion, live in areas of physical water scarcity. Rivers are drying up, groundwater levels are declining rapidly, freshwater fisheries are being damaged, and salinization and water pollution are increasing. Large areas of irrigated land in the Middle East, North Africa and Asia are now maintaining food production through unsustainable extractions of water from rivers or the ground.[vii] In China the groundwater overdraft rate exceeds 25 percent and it is over 56 percent in parts of northwest India.[viii] Both large and small holdings are affected. Arguably the small farms are worst hit.

Third, smallholdings remain of primary importance not only to agriculture but to rural development in the developing countries. Experience has amply demonstrated the power of agriculture as an engine for economic development.[ix] Very few countries have experienced rapid economic growth without preceding or accompanying growth in agriculture.[x] This is not because agriculture has a special capacity for rapid growth (although in certain situations growth can be very fast, e.g. during the Green Revolution) but because of the size of the sector; even modest rates of growth have a considerable multiplier effect. In Africa a one dollar increase in agricultural income leads to an increase in overall income of more than two dollars.[xi]

In effect there is a virtuous circle that hinges on agricultural development and, in much of the world, smallholders sit at the centre of this circle:

> *As agriculture develops – greater yields and production of subsistence and cash crops – smallholders become more prosperous and the landless also benefit through wage labour. Chronic hunger decreases. The rural economy also grows – through the creation of small rural businesses - providing more employment and improved rural facilities, especially schools and health clinics. Roads and markets develop so that the rural economy connects to the urban economy and to the growing industrial sector.*

Free trade provides opportunities for greater imports and exports. In particular high value agricultural exports can accelerate agricultural development, further intensifying the virtuous circle.

It has long been recognised that smallholders are in many respects highly efficient.[xii] Small farms produce more per hectare than large farms: many studies have shown there is an inverse relationship between farm size and production per unit of land (however, Paul Collier and Stefan Dercon point out this may be true of small versus large farms i.e. one ha versus ten ha but not very large farms i.e. one ha versus hundreds or thousands of ha).[xiii] In the developing countries where labour is relatively cheap and capital relatively expensive, there are few economies of scale. Household labour is the key to smallholder production – usually a family with long experience of the local environment and knowledge of what works and what does not. Because it is 'on the spot' the labour is readily available and motivated, and most important flexible, able to respond immediately to the vagaries of the faming calendar and adaptable to the frequent crises that affect the farm, whether they be pest and disease outbreaks, droughts or floods or slumps in market prices.

You can see this most clearly in the home garden of a smallholding, a traditional system of agriculture that goes back to the very origins of domestication (probably the first wheats were cultivated when the farmer, most likely a woman, brought seed back from the wild fields to sow on the midden by the dwelling).[xiv] Home or kitchen gardens are particularly well developed on the island of Java in Indonesia, where they are called *pekarangan*.[xv] Their immediately noticeable characteristic is their great diversity relative to their size: they usually take up little more than half a hectare around the farmer's house. Yet, in one Javanese home garden 56 different species of useful plants were found, some for food, others as condiments and spices, some for medicine and others as feed for the livestock - a cow and a goat, some chickens or ducks, and fish in the garden pond. Much is for household consumption, but some is bartered with neighbours and some is sold. The plants are grown in intricate relationships with one another: close to the ground are vegetables, sweet potatoes, taro and spices; in the next layer are bananas, papayas and other fruits; a couple of metres above are soursop, guava and cloves, while emerging through the canopy are coconuts and timber trees, such as Albizzia. So dense is the planting that to the casual observer the garden seems like a miniature forest. But it is not a natural ecosystem it is the product of intimate knowledge and daily care and attention, usually by the woman of the household (Figure 1).

For ecologists like me such gardens are a delight. But as Paul Collier warns, we must be careful not to romanticise.[xvi] The high labour input may be capable of producing a large and varied harvest, but the returns to the labour are small. Labour productivity is low and typically insufficient to bring people out of poverty. Steve Wiggins has estimated that labour productivity needs to be over US$700 per worker per year to get them and their dependents out of poverty.[xvii] For half the countries of Africa the average is less than US$350 (Figure 2).

In many respects this challenge lies at the heart of this conference. How can we increase the returns so that smallholder farming becomes a route out of poverty? It is not enough to help smallholders achieve subsistence, even if it is sustainable. They also need incomes – not least to pay medical bills and schooling, as well as pay for food when harvests are poor. The goal is not just sustainable existence but sustainable development.

Some analysts argue that this can only occur through large-scale farming. The obvious advantages lie in the economies of scale relating to the costs of transactions off the farm – procuring inputs, obtaining credit, and marketing; for example, the costs of meeting standards that satisfy buyers from processors and supermarket chains.[xviii]

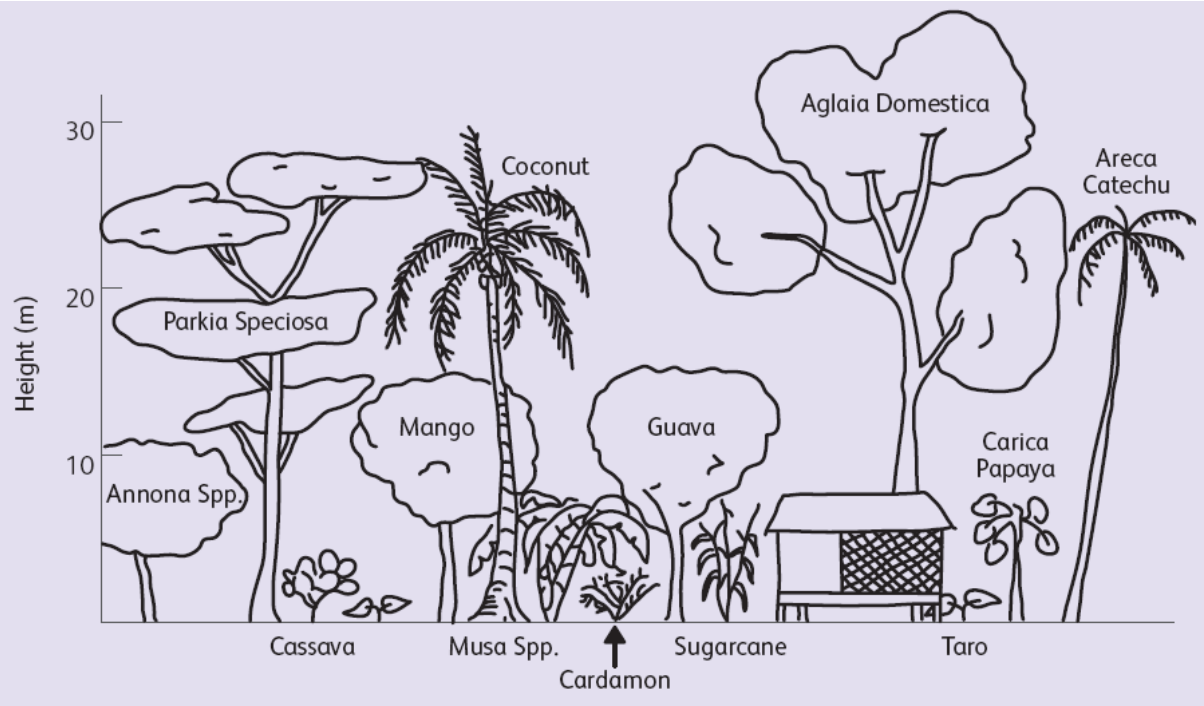

Figure 1. The diversity of Javanese home garden.[xix]

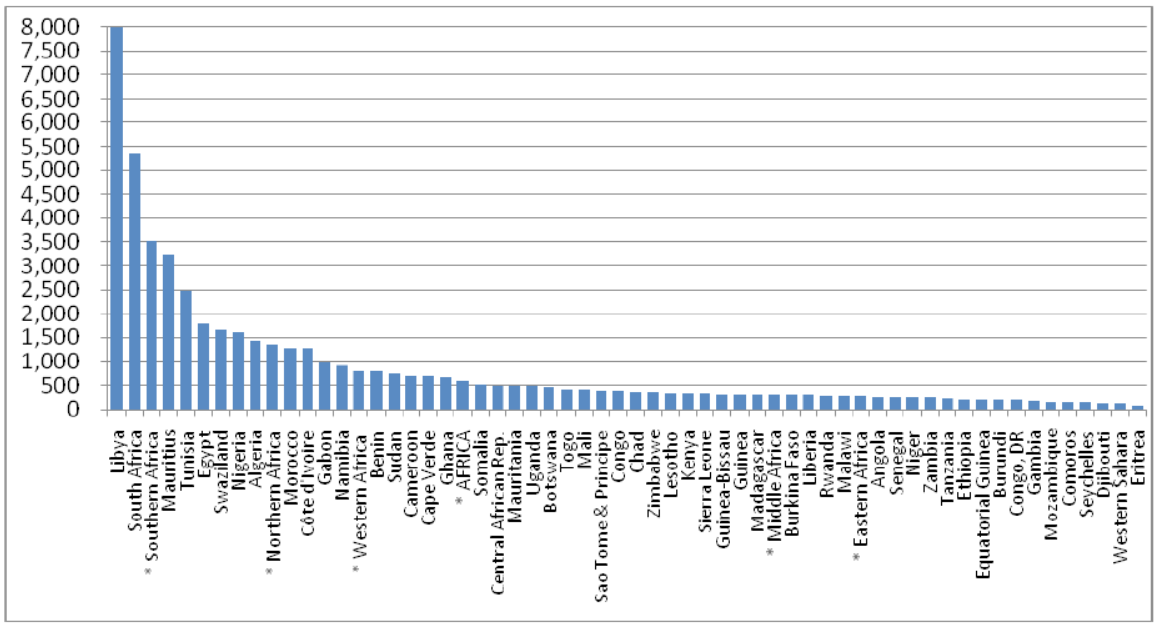

Figure 2. Labour productivity in African agriculture, 2003/2005, US$ per worker[xx]

But the experience of large farms in Africa is not all that positive. There have been spectacular failures, especially where inappropriate mechanisation has led to severe soil erosion as in the ill-fated Groundnut Scheme in Tanzania in the 1940s or the export vegetable cultivation in Senegal in the 1970s. Large farms in Africa require experienced management otherwise the costs and the

environment can conspire to bring about failure. Where they are appropriate and can be successful is when large capital investments are necessary, for example to support large processing plants that in turn require large-scale production. Examples are farms devoted to high-value and specialist crops such as fruit, vegetables, flowers, intensive pigs and poultry and for export crops such as sisal, sugar, tea, rubber and coffee.[xxi]

Contemporary dialogues about agricultural development and food security are plagued by contests between extremes – organic farming versus GM, subsistence versus cash cropping, small-scale irrigation versus large-scale and so on. But abundant experience tells us that the dialogue should not be about *either.. or* but should focus on *both… and*. Thus the way forward lies not in *either* small *or* large farms, but in making a deliberate choice of *both* small *and* large farms. They both have a role to play in Africa's future agricultural development. In Prabhu Pingali's words:

'under the right circumstances smallholders can be just as productive, just as innovative, just as competitive, and just as risk-taking as larger farms.'

At the same time, in other circumstances, large farms are appropriate. Large commercial farms can be close to the frontiers of technology, finance and logistics and hence globally competitive.[xxii] This has been the Latin American experience, with farms of more than 10,000 ha growing soybean in the Brazilian Cerrado and over 300,000 ha sugar estates in Southern Brazil, many focused on ethanol production. There are also some examples in Africa, including mechanized sorghum and sesame production in Sudan with farms averaging over 1,000 ha, and some over 20,000 ha.

Although these are impressive developments and it is clear that large-scale farming will have an increasingly significant role in achieving food security, smallholders, because of their sheer numbers and the total land area they occupy, will have to play the dominant development role at least for several decades to come. The question is: can we significantly increase their labour productivity?

Let me now illustrate the challenge with a fairly representative, although fictitious, smallholder in Africa. I will call her Mrs. Namarunda.[xxiii] Several years ago, her husband died. Her eldest son inherited the family farm, a single hectare running up one side of a hill near Lake Victoria. The soils are moderately deep and well drained, but they are acidic, highly weathered, and leached. Mrs. Namarunda's first son married and moved to Nairobi, where he is an occasional lorry driver and has children of his own.

Mrs. Namarunda was left on the farm with four younger children and the responsibility to produce food, fetch water, gather fuel, educate the children and take care of the family. But shortages of almost everything – land, money, labour, plant nutrients in soil exhausted from many years of continual crop production – mean that she is often unable to provide her family with adequate food. The two youngest children, in particular, suffer from undernourishment and persistent illnesses.

She starts each growing season with a maximum potential harvest of only about two tonnes from mixed cropping on her one ha of land. To survive, her family requires a harvest of about one tonne, so if everything goes right and the maximum harvest is achieved, it would be sufficient to meet their needs and to generate a modest income. But, during the course of every growing season, she faces innumerable threats to her crops that reduce her yields.

Weeds are her most persistent and pervasive problem. Her staple crop, maize, is attacked by the parasitic weed *Striga*, as well as by streak virus, various boring insects and a fungus which rots the ears. She has tried growing cassava as an "insurance crop" but it, too, was attacked, first by mealy bugs and green mites, then it was totally devastated by a new, super-virulent strain of African cassava mosaic virus. Her banana seedlings are infected with weevils, nematodes and the fungal disease Black Sigatoka. Her beans, which are intended as a source of protein for the family and nitrogen for the soil, suffer from fungal diseases. She also faces drought at some time during the growing season that again reduces crop yields. At the end of each season, what she actually harvests is usually less than one tonne. She and her children are often hungry, and there is no money for schooling or for health care.

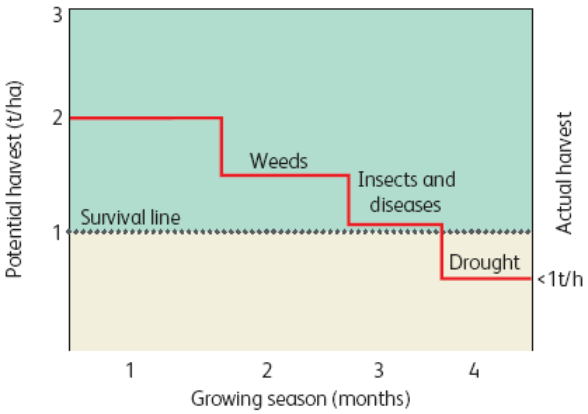

Figure 3. An insecure farm in Africa.[xxiv]

But it does not have to be this way. There are already solutions to many of her pest, disease and weed problems. New varieties can provide protection and will give greater resilience to drought. Part of the challenge is to ensure that the varieties and other technologies are appropriate, i.e.

They are productive, in particular they generate high levels of income;
The production they generate is stable and resilient;
They are readily accessible and affordable and;
They do not have significant environmental or human health downsides.[xxv]

It used to be thought that 'appropriate technologies' for smallholders were in some sense intermediate technologies – lying between traditional technologies and the conventional, industrial technologies. But experience suggests that any kind of technology can be appropriate, at least on the criteria described above.

Traditional technologies are approaches to problems that have been used by people for hundreds, if not thousands, of years. They can be thought of as having 'stood the test of time.' Some have clearly worked and still work today. For others there is no scientific evidence that they are effective.

Perhaps one of the most successful of traditional practices is the home garden that I mentioned before. Even more ubiquitous is the cultivation of traditional crop varieties, so-called land races, or of 'wild' plants. They may be domesticated to an extent and improved by farmer selection but usually retain their essential characteristics. Examples include the traditional maizes of Central America, the sticky rices of northern Thailand and the potatoes of Peru.[xxvi]

Most traditional technologies, however, are essentially subsistence technologies. They are stable and resilient in their performance but they rarely increase incomes.

To some extent this is also true of those intermediate technologies that combine the best of conventional and traditional technology. There are numerous examples. Some are simple, others more sophisticated. A good example is the development of an affordable and reliable treadle pump.[xxvii] For many years, engineers have been developing pumps which allow farmers to replace the arduous task of lifting irrigation water from shallow wells by bucket. The modern treadle pump is ideal in many respects – it is efficient and easy for farmers to use and maintain and is virtually fool-proof. It is also relatively cheap, as a result of a combination of public subsidies with private manufacture and servicing, and with community involvement. Such pumps can also help to increase incomes if the water is used to irrigate high value vegetable or horticultural crops.

Another form of intermediate technology is the ecologically based cropping system. An example is the MBILI system developed by an NGO called SACRED (Sustainable Agricultural Centre for Research Extension and Development in Africa) in western Kenya.[xxviii] The system was developed on farms with farmers as key partners in the management and experimentation. It consists of

intercropping double rows of maize with double rows of higher value legumes such as beans, green gram and groundnuts. This allows for better light penetration favouring the legumes. Yields of maize are about five tons/ha and of legumes about a ton (Figure 4).[xxix]

Most conventional, industrial technologies such as synthetic fertilisers and pesticides and modern irrigation systems provide high income returns and hence enhance labour productivity, as the Green Revolution clearly demonstrated.[xxx] It is why they are so ubiquitous in the farms of the industrialised world. But they tend to be expensive which is why they are not so widely used in the developing countries. They can also have deleterious environmental effects.

For smallholders in the developing world, the answer is to ensure they are used with much greater precision. An example is the technique of fertiliser microdosing developed in Niger. Each microdose consists of a six gram mix of phosphorus and nitrogen fertiliser which just fills the cap of a Coca-Cola bottle. The cap of fertiliser is then poured into each hole before the seed is planted. It equates to using 4 kg/ha, three to six times less than used in Europe and North America. Microdosing has been credited with boosting millet yields by 50 percent to 100 percent in the Sahel, thereby helping to reverse a 50-year trend of declining yields and rising soil degradation.[xxxi]

The same principle can be applied to herbicide use. Far too often herbicides are sprayed relatively indiscriminately, killing not only weeds but other wild plants and sometimes damaging the crops themselves. Yet there are extremely serious weed problems that have to be tackled. One such is *Striga*, or witch weed, a devastating parasitic weed in Africa that sucks nutrients from the roots of maize, sorghum and other crops. *Striga* is also readily controlled by an herbicide, imazapyr, but this tends to damage or kill the maize crop. Recently, a mutant gene in maize has been discovered through tissue culture (see below) that confers resistance to the herbicide and is being bred into local maize varieties. The maize seed can be dipped into the herbicide before being planted and as the maize plant grows the herbicide will kill the weeds in the ground. Early trials are showing increases in yield from half a tonne per hectare to over three tonnes.[xxxii]

Finally, recent years have seen the development of new scientific "platforms" for innovation, derived from fundamental discoveries in the physical, chemical and biological sciences. These have the potential to be developed simultaneously for the needs of the industrialised and the developing world, and in the right circumstances can be appropriate for the needs of developing country smallholder farmers. These new platform technologies include Information and Communication Technology (ICT), Geographic Information Systems (GIS), nanotechnology and biotechnology.[xxxiii]

In its modern form, crop biotechnology comprises:

Marker-aided selection – particular DNA sequences at specific locations can be used to detect the presence of a gene and so speed up the breeding process.

Tissue culture – which permits the growth of whole plants from a single cell or clump of cells in an artificial medium. This can be used to generate planting materials that are known to be free of disease. Tissue culture has produced new pest and disease free bananas in East Africa that can yield up to 50 tonnes/ha.[xxxiv]

Recombinant DNA or genetic engineering or modification (GM) technology – which enables the direct transfer of genes from one organism to another.

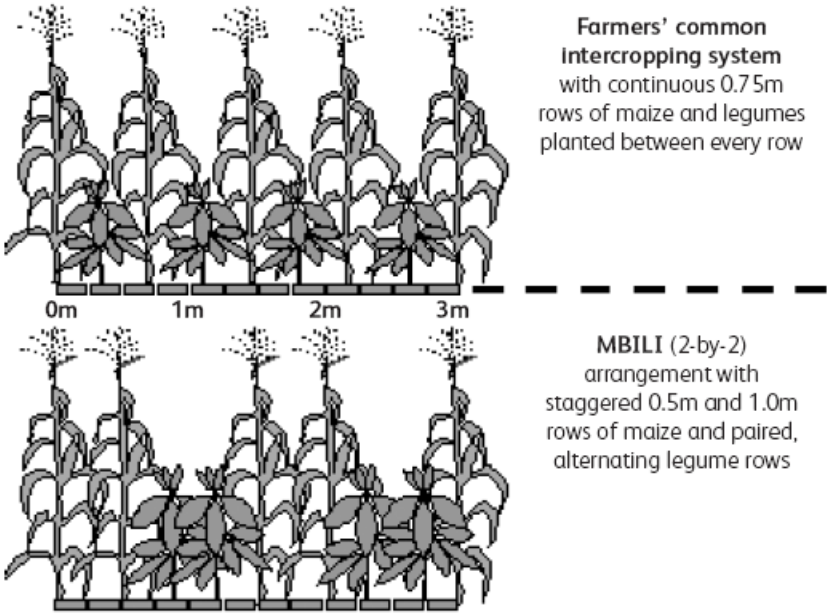

Figure 4. Intercropping systems in East Africa.[xxxv]

The first two biotechnologies, in the hands of international and national agricultural research centres are already delivering improved staple crops to poor farmers. GM technology also has the potential to benefit smallholders in developing countries. At present this largely derives from engineering crops to express a bacterial gene that controls certain insect pests, so reducing the need for harmful synthetic pesticides. Thus *Bt* cotton, that contains a gene producing an insecticidal protein in the plant, has proved to be especially beneficial in a number of countries. Around the world nearly 13 million 'small and resource poor' farmers are growing *Bt* cotton.[xxxvi] Burkina Faso, the largest cotton producer in Africa adopted *Bt* cotton on a commercial scale in 2008. In the second season it was being grown on 100,000 ha with yields up to 50 percent higher than the conventional cotton, and the number of sprays reduced from an average of eight to at most two.[xxxvii] A World Bank review of the benefits of *Bt* cotton in Argentina, Brazil, Mexico, India and South Africa showed increases in yields of between 11 percent and 65 percent, and increased profits as high as 340 percent with significantly reduced use of pesticides and pest management costs (Table 1).[xxxviii]

Of course, one way of ensuring that technologies are appropriate is to involve smallholders intimately in the development of the technologies.[xxxix] This means not just involving them in testing new technologies and their local adaptation, but engaging them much earlier in the process, helping to identify objectives for research and development and participating pro-actively in the experimentation. Under the headings of Participatory Rural Appraisal (PRA) and Participatory Learning and Action (PLA) there is a now a formidable array of methods which allow communities to analyse their own situations and, importantly, to engage in productive dialogue with research scientists and extension workers.[xl]

In the 1990s, farmers in the arid Khanasser Valley in northern Syria started planting olive trees. They did not have a long history of olive cultivation to draw knowledge from, and with little water available for irrigation and poor soil quality, yields were far from ideal. The International Center for Agricultural Research in the Dry Areas (ICARDA) came to the area in 2003 and formed a committee of farmers and local extension workers to begin a process of participatory research, evaluation and innovation. Out of this a number of new technologies were identified and adopted.[xli] They include:

Table 1. The economic and environmental benefits of growing Bt cotton in developing countries.[xlii]

	Argentina	China	India	Mexico	South Africa
Added yield (%)	33	19	26	11	65
Added profit (%)	31	340	47	12	198
Reduced chemical sprays (number)	2.4	–	2.7	2.2	–
Reduced pest management costs (%)	47	67	73	77	58

• *Water Harvesting* – the construction of V or fishbone-shaped, stony-earth bunds around each of the trees to create micro-catchments which can contain water around the tree and control soil erosion.
• *Stone Mulching* – covering the soil around the tree trunk with stones to reduce evaporation losses from the soil surface. Project experiments showed that basalt stone worked better than the chalky limestone the farmers had previously been using.

• *Sub-surface Insert Irrigation* – One of the farmers in the valley suggested an irrigation method he had seen being used in Tunisia. A stone pocket or gravel layer is constructed underground around the root zone of each tree. A PVC tube is then inserted vertically into the pocket and water is applied through the tube, so that it goes directly to the deeper roots.

Appropriate technologies of one kind or another have much to offer Mrs. Namarunda. They can solve most if not all of her problems, some quickly, some over a longer time. She can then expect to harvest at least 2 tons from her hectare. This will allow her to feed her family and leave part of the farm to grow crops for sale and provide the income she desperately needs (Figure 5). But, of course, she needs access to these technologies and much else besides.

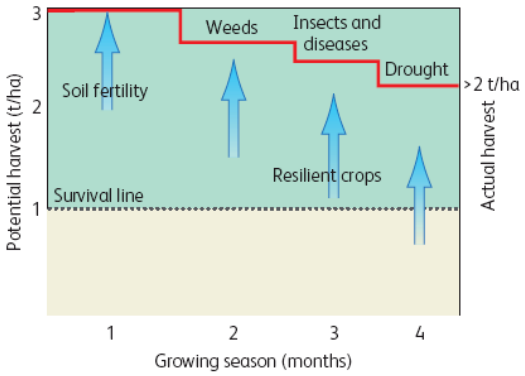

Figure 5. A secure farm in Africa.[xliii]

In the words of Joe De Vries of the Alliance for a Green Revolution for Africa (AGRA), '*Africa's food needs cannot be outsourced. Food needs to be grown here in Africa, and that process starts with getting improved seeds into the hands of farmers*." Some of the new seeds are being produced by the multinational companies. Most of the seeds appropriate to her conditions, however, are coming from partnerships between the international research institutes of the Consultative Group for International Research (CGIAR) and national research institutes, such as the Kenya Agricultural Research Institute (KARI). The latter has some 14 maize hybrids currently available for different regions of Kenya.[xliv] Attention is now turning to the creation of relatively small, locally based seed companies under AGRA's Programme for Africa's Seed Systems (PASS). So far they have provided start-up capital for 35 African seed companies who have collectively produced 15,000 million tons of certified seed.[xlv]

Producing new locally appropriate seeds (and fertilisers) is part of the challenge but equally important is making them accessible to farmers like Mrs. Namarunda. Another of the innovative actions of AGRA (building on the work of the Rockefeller Foundation) is to facilitate the creation of village level agro-dealers. AGRA has trained and supported over 5,000 such agro-dealers in eastern and western Africa. Although the agrodealer stores are small (what Americans call 'Mom and Pop stores') they are collectively having a major impact, providing USUS$45 million worth of improved seeds, fertilizers and other inputs in 2008. They sell key inputs to farmers in small, affordable quantities and, most significantly, they reduce the distances farmers have to go to get inputs – in one area of Kenya from 17 kilometres in 2004 to 4 kilometres in 2007.[xlvi]

Providing physical access to inputs is one challenge but the new seeds and other inputs need to be affordable. They have to be priced appropriately; a diversity of seed producers can provide the necessary competitiveness to bring prices down. But smallholders also need subsidies and credit, especially in the early years of the new agricultural development. The experience of Malawi has shown what a subsidy programme can do in terms of seed and fertiliser uptake; yields and total production increasing dramatically in the first few years.[xlvii] It is questionable, however, whether such high levels of subsidy are sustainable on a national basis.

The medium- to long-term solution is a combination of better targeted, smart subsidies and the provision of microfinance. In recent months there has been much criticism of micro-credit schemes, especially in Asia where a large, private industry has grown up, in many instances charging very high rates of interest. It is worth remembering that the first such schemes back in the 1970s such as SEWA – the Self Employed Women's Association – of Hyderabad were based on small groups of individuals, who knew each other and took responsibility for assessing and approving loan approvals. We need to recapture that spirit of lending and here the agrodealer network can provide a basis for greater intimacy and locality for credit programmes. As a first step, in Tanzania the National Microfinance Bank is providing US$5 million in loans to agro-dealers to assist them in providing better service to small farmers.[xlviii]

The final element in the use of new appropriate technologies is the creation of incentives for adoption. Smallholding is a risky business and farmers need to know they will be fairly rewarded if they take on the risk and also have some recompense, if through no fault of their own, they have a disastrous year.[xlix] There are three key components: land tenure, insurance schemes and output markets.

Land tenure is probably the most complicated to deal with. Large numbers of smallholders have insecure rights to their land. In Mrs. Namarunda's case her land is owned by her son and presumably he could take it away or sell it, leaving her destitute. Where small-scale land ownership is common and has a legal basis it is imperative to make sure ownership is registered and secure. In one pioneering programming, Rwanda is using satellite technology to resolve disputes and regularise ownership.[l] It is proving cheap and easy to use, with farmers showing considerable skills in using remote sensing images to discuss and resolve boundary disputes.

It is more common, however, for some form of customary tenure to apply and the challenge is to give this legal status. For example, in Eritrea in 1995 the majority of customary rights were transferred into lifetime rights under guaranteed government protection. Tanzania, Uganda and Mozambique also all recognise customary tenure, although in different systems, as legally valid.[li] The aim in all these instances is to introduce new arrangements and processes that provide sufficient rights to encourage smallholders to invest in technologies and other inputs that will improve their land over the medium-to long-term.

If they are to improve their lives and livelihoods smallholders have to take risks. In many instances the downsides of adopting a new technology or borrowing finance can be devastating. A drought or a flood will not only bring starvation but can wipe out all a family's savings and force them to sell their assets. In India some 2 million weather index insurance products have been sold through private insurance since 2003, while in Africa a number of similar schemes are currently being piloted.[lii]

One such scheme helps small- or medium-scale livestock farmers or pastoralists to insure against the risk of investing in areas of regular drought. It is based on NASA satellite images which measure

vegetation and a model which predicts livestock mortality based on the vegetation index.[liii] Insurance companies then pay out twice a year for any events that have occurred where the predicted mortality was over a certain threshold. The scheme has multiple benefits: it helps households get loans, prevents them from having to use self-insurance (i.e. having more cattle than they really need) and aids the Kenyan government, who normally must make big pay-out to farmers after droughts to keep them out of extreme poverty.

Finally, and in some respects most important of all, is the provision of markets that will buy from farmers for a fair price in an open, honest and non-exploitative fashion. There have been numerous horror stories of farmers investing in new seeds and fertilisers, obtaining high yields only to find they cannot sell their produce, except at a loss. This will put off even the least risk averse from investing in new technologies.

Part of the answer lies in creating local village grain storage systems, managed by village cooperatives, which will keep some reserves for the hunger season but market the rest at the best prices. This depends on having a countrywide network of small and large markets and a scheme such as that run by The Kenya Agricultural Commodity Exchange (KACE) a private-sector firm that links sellers and buyers of agricultural commodities and provides relevant and timely marketing information and intelligence using a mobile phone Short Message Service (SMS) system.[liv]

Smallholders are also being encouraged to use Warehouse Receipt Systems. One such system in Tanzania and funded by IFAD, permits farmers to borrow from a Savings and Credit Cooperative up to 70 percent of the value of the stored grain, but also to sell some of their stock several months after harvest when prices are higher.[lv]

So far, I have deliberately talked with a positive optimistic slant; I believe much is possible on both a short- and long-term. But I have ignored the potential adverse impacts of climate change, which threaten to negate what can be done.

Of course, there is a great deal of argument about climate change at present. The deniers are having a field day exploiting inconsistencies, inaccuracies and exposing questionable actions by some climate scientists. The media delights in such controversy, but we need to be aware that for Mrs. Namarunda climate change is not a fantasy; it is already affecting what happens on her one hectare farm.

Further north from where she lives the rainfall pattern in the Sahel has dramatically altered since the 1970s bringing prolonged drought with periodic heavy rains and devastating flooding on the parched soils. Northern and southern Africa are becoming drier and hotter; the pattern of the Asian and East Asian monsoon is changing; river regimes in Asia and Africa are altering; everywhere the extremes of weather are becoming more frequent and/or more severe. It is not possible to assign any extreme event to anthropogenic climate change but the trends are consistent with a globe being warmed by increased release of greenhouse gases.[lvi]

It seems that everywhere people are aware of the changes. Ask a group of smallholders whether the climate is changing and they will say, yes of course and will describe what is happening to their community. Is it affecting your cropping patterns and practices? Yes they will reply. Asking what you are doing about it will elicit a detailed account of their responses.

In the Atlas Mountains of Morocco the villagers now cannot grow enough barley to feed themselves, because of the continuing lack of rainfall. They are trying out drip irrigation as a possibility for high-value crops that they can sell in the markets on the coast. They are also harvesting some of the wild, typically drought tolerant, plants growing on the hills around the villages – for example, the Argan tree that produces high quality oil like an olive oil, and the honey from euphorbia. But the women are doing the harvesting, and they are getting little return. The challenge is to process the oil and the honey in situ and derive some of the value added in the villages.

Another example is in the village of Nwadhajane in Southern Mozambique, the birthplace of the great Mozambique leader, Eduardo Mondlane.[lvii] The villagers are very aware of climate change affecting them and have already taken significant measures to counteract the worst features. They have two

kinds of land – lowland and highland. On the former the crops are very productive, but are washed out by periodic floods; in the highlands they produce good crops in the flood years but poor crops during the droughts. The villagers' response has been to create several farmer associations that have reassigned the land so that each farmer obtains a portion of highland as well as some lowland. The farmer associations are also carrying out experiments with drought-resistant crops.

These are encouraging examples of smallholder experimentation and adaptation, but the solutions also require major government interventions - improvements to irrigation and water storage schemes, coastal protection, river bank strengthening – together with international experimentation on the development of drought and flood tolerant crop varieties. Adaptation is going to help Mrs. Namarunda if the top down actions of government are melded with the bottom up adaptive capacities of rural communities, in particular the millions of smallholders in the world who are already suffering.

The same principal applies to the challenge of mitigating climate change. There is still not enough recognition of the fact that agriculture and deforestation are major producers of greenhouse gases - about 30 percent of the total.[lviii] Contributors are: (1) the carbon dioxide resulting from deforestation and the loss of soil carbon in conventional agricultural practice, (2) the methane emitted by flooded rice and from enteric fermentation in cattle, and finally (3) the nitrous oxide from microbial transformation of nitrogen in the soil and in manures. The amounts of methane and nitrous oxide are relatively small, but they are the gases that have the biggest effect on global warming.

It is possible to reduce nitrous oxide and methane by various means: reduced tillage, improved grassland management, restoration of degraded lands, more efficient use of fertiliser, improving water and rice management, planting trees and agroforestry, altering forage and sustainable use of animal genetic diversity, storage and capture technologies for manure, conversion of emissions into biogas and low emission rice varieties and livestock breeds. But the biggest challenge is to get significant amounts of the carbon back into the soil. Rattan Lal has estimated that we could return at least half of the soil organic carbon that has been lost to the atmosphere since the industrial revolution through a 25-50 year programme of soil sequestration.[lix] In his words

> *'..soil C sequestration is a truly win–win strategy. It restores degraded soils, enhances biomass production, purifies surface and ground waters, and reduces the rate of enrichment of atmospheric CO_2 by offsetting emissions due to fossil fuel.'*

But the question for us is — what is in it for Mrs. Namarunda? 70 percent of the entire agriculturally derived greenhouse gases come from developing countries. Moreover 70 percent of the mitigation potential is in developing countries, and 90 percent of that potential is carbon sequestration. So collectively the Mrs. Namarundas of this world could make a huge difference. But why should she?

One possibility, of course, is that she seeks out win-win practices. Conservation farming – using minimum or no-till practices - is a good example. It conserves soil and water, increases carbon in the soil and produces higher yields in drought situations. An interesting agroforestry technology that is already being promoted on a large-scale in Africa is the planting of the legume tree, *Faidherbia albida*.[lx] This tall tree has the distinctive feature of shedding its leaves in the wet season and putting on green growth in the dry season. Maize can be grown under the trees in the wet season, fertilized by their nitrogen fixation and the leaf mulch. Field trials have shown that 3 tons of maize per ha can be produced without added fertiliser, and at the same time the system will return to the soil some 2-4 tons of C/ha. That is a large amount of carbon to put back.

Perhaps we should take leaf out of the Reducing Emissions from Deforestation and Forest Degradation or REDD programme, which is a way of compensating people who live in forests and others for preserving forests.[lxi] It is proving to be a successful way of promoting not only forest protection but also regimes of selective and sustainable logging that can provide incomes for rural households. Agriculture has somehow to produce a similar scheme so that the Mrs. Namarundas of this world will be compensated for putting carbon back in the soil. It will not be easy. There are challenges in measuring the level of carbon sequestration and in finding the sources of the funds required and a fair means of compensation. But in principal it is doable.

Finally I want to briefly touch on a key question. In simple terms the question is: If a local community, perhaps aided by the national government or by an aid donor or by an NGO, has been able to build a productive, stable, resilient and equitable system of technologies and/or processes that works and appears sustainable, can it be replicated on a much larger scale to benefit not just hundreds but many thousands of smallholders? The challenge facing us is to help take these local systems, especially those that significantly increase farmer and labourer incomes, and to scale them up so that the poor, both farmers and the landless, can benefit in a way that brings about the kind of virtuous circle of rural development I described earlier.

One example of scaling up is the Ugandan Vegetable Oil Development Project, a partnership between IFAD, the government of Uganda and Bidco, a large private investor. The partnership constructed an oil palm refinery and oil palm plantations, disseminated technical expertise and investment, and involved smallholders through the Kalangala Oil Palm Growers Trust, that represents their needs and interests. Once fully established the project will result in 10,000ha of land being under oil palm production with one third of this belonging to smallholders.[lxii]

Another example is the East Africa Dairy Development Project, which started in January 2008 in Kenya, Uganda and Rwanda, and is a partnership between the International Livestock Research Institute (ILRI) (responsible for monitoring and evaluation), Heifer International (animal husbandry), Technoserve (milk markets and milk policy) and ABS (a US based company, specialising in animal breeding).[lxiii] It has started to help small rural producers gain access to information on best practices for such things as feeding, breeding and new technologies, and has also established hubs where milk can be collected, cooled, pasteurised, marketed and sold.[lxiv] To date, 20 Dairy Farmers Business Associations (DFBA) have been formed to manage the business around each hub. There are a total of over 65,000 registered farmers and ten DFBAs are currently selling a total of 141,000 litres per day of milk to three processors.[lxv]

Although there is considerable experience of going to scale there is no simple recipe. However, some principles are beginning to emerge:

The first is that the private sector has much of the necessary experience, skills and processes to make scaling up work. This is primarily because any agricultural technology or process that significantly increases income is 'marketable' and hence saleable.

Second, is that rarely can the private sector, whether indigenous or foreign, be left to itself to bring about the scaling up transformation. In most cases there has to be a public-private partnership. Sometimes this will simply consist of governmental action to provide the right kind of enabling environment for the private sector to operate. In others, more formal public-private-community partnerships are required that harness the different qualities and comparative advantages of the relevant actors.

Third, each value chain is likely to be different. For instance, scaling up practices will vary for livestock, export high value crops and local staples.

Fourth, if equitable benefits are to be derived, the value added needs to be biased to the lower levels of the value chain. Scaling up cannot be seen as only of benefit to the larger, better-off producers.

Fifth, and related to the previous point, there is likely to be a significant role for farmer associations, cooperatives and other bodies that will fight to ensure the benefits are widely shared.

Finally, much of the success of scaling up depends on the details of the pathways, processes and deals between the partners that are struck.

Some years ago I published a book entitled '*The Doubly Green Revolution'* which laid out the argument for a new kind of agricultural revolution that aims to *'repeat the success of the Green Revolution on a global scale in many diverse localities and be equitable, sustainable and environmentally friendly.'*[lxvi] I believe the concept and its related practices are as relevant today as they were then, if not more so.

In this speech, I have tried to lay out the elements of a comprehensive framework for support of smallholder farmers in the developing countries that draws on the concept of a Doubly Green Revolution. Its aim is to enable national governments, in partnerships with aid agencies, NGOs and the private sector, to help smallholders achieve food security for themselves and their communities and at the same time sustainably increase their incomes. I am an optimist but, more important, my experience over the last 50 years convinces me it can be done.

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