

# What ICRISAT Thinks ...

*There is Hope and Prosperity in the Drylands*

William D Dar



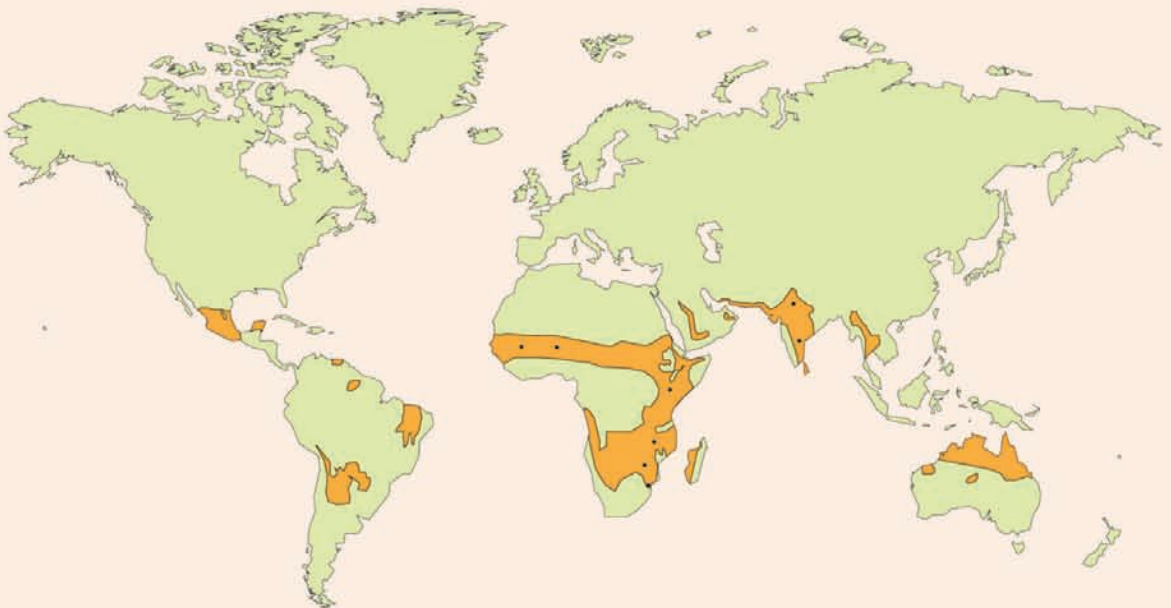
International Crops Research Institute for the Semi-Arid Tropics



**Citation:** Dar, W.D. 2007. What ICRISAT Thinks...: There is Hope and Prosperity in the Drylands. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid tropics. 68 pp.

## ICRISAT's Focus Area: The Dry Tropics

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) conducts research in the semi-arid or dry tropics of Asia and sub-Saharan Africa, where agriculture is the backbone of economies. Encompassing 55 countries, the dry tropics is home to the poorest of the poor, with a very fragile ecosystem and extreme climatic variations. ICRISAT addresses these critical challenges by developing problem-based and impact-driven research. The challenges of persistent poverty, food security, malnutrition and health are addressed by working with diverse partners on five crops important to the poor – sorghum, chickpea, pigeonpea, pearl millet and groundnut, agroecosystem development and management, the driving forces influencing farmer-to-market linkages, seed systems, and policy and impact generation.



# What ICRISAT Thinks . . .

There is Hope and Prosperity in the Drylands

William D Dar



ICRISAT

**International Crops Research Institute for the Semi-Arid Tropics**

Patancheru 502 324, Andhra Pradesh, India

[icrisat@cgiar.org](mailto:icrisat@cgiar.org)

2007

# Contents

1

Preface

3

Niger's Hunger  
Crisis

7

Invigorating  
Seed Systems  
in Africa

11

Diversity  
Delivers the  
Dryland Goods

17

Don't Desert  
Drylands!

21

Biofuel Crops:  
Power to the  
Poor

26

Climate Change:  
Back to the  
Future

31

Defeating  
Dryland Risk

37

Hope from High-  
Value Crops

45

Safe and Healthy  
Dryland Foods

50

Dryland  
Development  
Pathways

54

Feedback

## About the Author



**William D Dar**, PhD, is the Director General of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) near Hyderabad in Andhra Pradesh, India, since January 2000. Dr Dar holds the distinction of being the first Filipino and Asian to be Director General of ICRISAT and Chair of the Alliance Executive of the Alliance of Future Harvest Centers in 2005, a collegial body that facilitates collective action among the 15 CGIAR Centers. He is also currently Chair of the Committee on Science and Technology (CST) of

the United Nations Convention to Combat Desertification (UNCCD). Dr Dar has also been a member of the UN Millennium Task Force on Hunger.

Prior to joining ICRISAT, he served as Presidential Adviser for Rural Development, and Secretary of Agriculture in the Philippines (equivalent to Minister of Agriculture), the first ever alumnus of the University of the Philippines Los Baños (UPLB) to become one. Before this, he was Executive Director of the Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development (PCARRD), Director of the Bureau of Agricultural Research (BAR) of the Philippine Department of Agriculture (DA) and Vice President for R&D and Professor of Benguet State University (BSU), Philippines. Dr Dar's transformational leadership has turned ICRISAT into a forward-looking institution, which is now ranked as 'Outstanding' among the CGIAR Centers.

Dr Dar's passion is to help alleviate the conditions of the poor people living in the semi-arid tropics of Asia and sub-Saharan Africa.

## Preface

Research often yields much higher payoffs than other types of sustainable development investments, but this value proposition is difficult to communicate to non-specialists. By its nature, research is complex, technical, and unending – an answer to one question raises a host of others. Conclusions and lessons must often be couched in tentative and conditional terms.

This is the communications challenge tackled by 'What ICRISAT Thinks' (WIT). WIT translates research into meaning. Richly illustrated, it synthesizes diverse, global, evolving science to identify important lessons and actionable steps. WIT is especially geared to distill those aspects of science that donors and stakeholders are most interested in: the 'why' and the impacts of the science that they are investing in.

WIT is written by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), a non-profit international agricultural research-for-development institute headquartered near Hyderabad, India. WIT conveys how partnership-based research helps reduce hunger, poverty and environmental degradation in the impoverished drylands of the developing world; and where the key opportunities lie for high-return investments for the public good.

Formatted as a letter from the Director General, WIT has been issued quarterly by email since late 2005. All WITs are also posted and downloadable at <http://www.icrisat.org/enewsletter.htm>. This book is a compilation of WITs produced through 2007.

WIT is worded in a direct, personal style, rich with high-quality photos and graphics. Topics are chosen to coincide with issues of current high donor concern (e.g. famine in Niger; climate change; risk in the drylands; biofuels; high-value crops). ICRISAT scientists contribute source information and a scientist-writer synthesizes and interprets this information in the WIT style.

WIT aims to stir up conversation. It challenges conventional wisdom, taking advantage of ICRISAT's long experience and expertise on the topics that it addresses, and putting forward unique and sometimes controversial views. WIT is distributed with a covering email inviting recipients to reply to the Director General with their own insights and comments.

This has opened a vigorous and valuable new communications channel with these key stakeholders. Closer communications improve relationships and generate new partnership ideas and initiatives. WIT also enables partners to better articulate to their own constituencies,

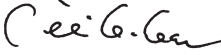
how such research partnerships are delivering good value.

We realize that many of our stakeholders can not travel to our remote locations to see the work that WIT describes in the field. So WIT will, over time add a multimedia dimension. It will be accompanied by short web-uploaded video clips (2-4 minutes) showing the work in the field. ICRISAT was the first (jointly with CIMMYT) across the CGIAR to implement this cost-efficient, web-enabled digital video web clip technology. For an example relating to the topic of our first WIT, on ending hunger in Niger,

please visit [http://www.icrisat.org/Investors/Video\\_Clips/Microdosing.htm](http://www.icrisat.org/Investors/Video_Clips/Microdosing.htm)

We hope you find these WIT letters stimulating and informative. Even more important, we hope that they give you a sense of the same excitement and promise that we feel as we forge ahead with partners on these vital research-for-development initiatives.

Sincerely yours,

  
**William D. Dar**  
Director General





## Niger's Hunger Crisis

Niger was the focus of the world's attention this year due to the recent famine; who will be next?

The food shortage has been attributed to drought and locusts causing a millet shortfall the previous year. But we have a different take on this.

Our research shows that poor soil fertility, rather than drought, is the major food-production constraint across much of the West African Sahel. When plants are malnourished their poor root systems cannot

collect the rainwater that falls. The present crisis in short, is a result of wasting water, rather than a shortage of water.

This situation can be remedied by rectifying the severe P and N deficiency of these soils through tiny doses of fertilizer – just one-sixth or less of the rates used in the developed world – which will allow the plants to capture more water, increasing millet yields by 70% on average.



We call this ‘microdosing’ – applying small amounts of fertilizer with the seed rather than spreading the fertilizer all over the field. Microdosing is affordable to the poor and gives plants a quick start and earlier finish, avoiding end-of-season drought. Ten dollars’ worth of fertilizer on one hectare delivers farmers about fifty extra dollars worth of millet.

A large majority of rural Nigeriens depend on millet farming for their food security. Increased productivity could have enabled them to feed themselves instead of becoming vulnerable to



*View from the air: Traditional millet (no fertilizer) at Banizo Umbo, southwest Niger, 510 mm rainfall. (Photo taken 150 m above ground.)*

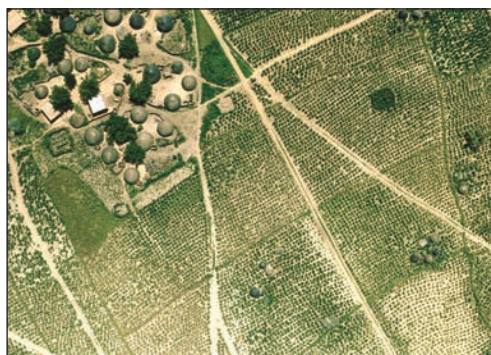


*The ground view: A traditional field with a microdosed field in the background.*

the soaring prices caused by the shortfall.

So what is holding back the adoption of the system? Four things: access to fertilizer; access to credit; insufficient flows of information and training to farmers; and inadequate policies. We are working closely with FAO to help farmers form cooperatives, or in French ‘warrantage associations’ to overcome these hurdles.

Warrantage and microdosing have been tested by 5,000 farmers by FAO with good results. Instead of selling grain for low prices, farmers pool their grain after harvest, and are issued cash loans against the collateral of the stored grain. With this they participate in collective fertilizer purchases for the next season. Free or subsidized fertilizer is not given to farmers. As grain prices rise in the months following harvest, the value of farmers’ collateral also rises, enabling them to



*View from the air: Millet microdosed at Kara Bedji, southwest Niger, 590 mm rainfall. (Photo taken 150 m above ground.)*

pay back the loan including interest by selling the grain. The associations also create information channels to reach farmers, for example showing them ways to increase the organic matter content of their soils, which is vital for long-term sustainability.

The food shortfall that caused the Niger famine in 2005 was 11%. If only one-quarter of the country's farmers had microdosed in 2004, the food deficit would have been erased. It would have cost about US\$20 million to get the system established widely across the country – but would have

saved donors up to US\$80 million in emergency food aid and Nigerien consumers about US\$70 million in lower food costs.

In better years, microdosing would create a surplus that could be used to expand strategic reserves (if policy accommodated it), protecting Sahelian countries against severe droughts in future years.

In recent years, USAID assisted ICRISAT to complement FAO's effort for demonstrating the technique in Burkina Faso, Niger and Mali, raising the total to more than 12,000 farmers



*Farmers using warrantage to store their grain in village warehouses until prices rise, so they can afford to buy fertilizer.*

reached. And we recently won a competitive grant from CORAF (with funds from the African Development Bank) to continue to disseminate microdosing/warrantage.

The CORAF endorsement is important because it signals support from the region itself, and confirms the strategy's alignment with NEPAD and FARA priorities. We encourage developed-world investors to build on such regionally-supported priorities to enable us to disseminate microdosing/warrantage more widely.

Microdosing is a prime example of the huge payoffs that are possible from long-term research investments. Unrestricted core support complemented by supplementary funding from BMZ/GTZ and USAID since the early 1990s enabled us to conduct

this research in partnership with Niger, Mali, Burkina Faso, IFDC, TSBF-CIAT, FAO and the University of Hohenheim (now through the University of Kassel). These investments now place us on the threshold of major impact to reduce human suffering.

We believe we now have enough evidence to confidently scale-up microdosing and warrantage across the Sahel. Combined with more supportive policies, this would set Niger and its neighbors on a positive self-development pathway that would finally bring an end to dependency on food aid when drought strikes.

We think it is high time that the world community set aside its despair and resignation about the Sahel, and start implementing a solution that is at hand today.



# Invigorating Seed Systems in Africa

## Improved seed reduces hunger and poverty

More than a quarter-century of CGIAR research demonstrates that improved seed is a powerful means for promoting sustainable development. It reduces hunger and increases prosperity for the majority of rural poor, who engage in farming. It also reduces food costs for impoverished urban dwellers.

In the drylands where ICRISAT focuses, for example, rosette virus-resistant groundnuts (peanuts) and fungal wilt-resistant pigeonpeas have made the difference between bounty and desperation for thousands of farmers, and are making more nutritious food available to consumers. Improved grain quality in the new varieties to suit the demands of high-value urban and export markets is delivering additional income gains that these poor urgently need.

In addition, early-maturing, high-yielding sorghums and millets deliver large yield gains as soil fertility improves (an issue I raised in the previous issue of 'What ICRISAT Thinks'). Improved varieties derived from breeding research by ICRISAT and its partners are now grown on about one million hectares of Africa's drylands.

Looking to the future, another 25% yield gain is expected from 'hybrid' varieties of sorghum, millet and pigeonpea that now are in advanced stages of development. Hybrids are also better able to withstand drought and other stresses.

## Delivering on the promise

Sadly though, many dryland farmers are yet to benefit from these exciting gains, simply because improved seed is not reaching them. Seed markets within individual African countries are



*A happy farmer in Western Kenya growing a crop of rosette virus-resistant groundnut.*

too small to support Western-model commercial seed industries, while outdated seed laws constrain the cross-border seed trade that could enlarge those markets.

Furthermore, centralized seed distribution, whether by governments or the private sector, is costly because small-scale dryland farmers are dispersed across vast areas, requiring millions of tiny sales transactions. Faced with these drawbacks, many multinational seed companies have simply stayed away from these areas and crops, and many government seed agencies have faltered.

If it is not profitable to sell to smallholders, what about free seed giveaways? This has often been tried following natural disasters and conflicts. But too often this seed was not carefully tested and therefore put farmers at risk of crop loss or failure. Seed giveaways also undermine local and indigenous seed enterprises, and thus are not a sustainable solution.

## What can be done?

On the policy front, we are contributing to discussions to harmonize regional seed regulations. These discussions benefit from research showing that a good international varietal testing system can help identify multi-country agro-ecosystems where a new improved variety will perform well.

We are also helping countries solve the over-centralization problem. For example, Mozambique, with ICRISAT advice, has changed its approach to concentrate on creating initial seed of the new varieties, while devolving the mass distribution of those varieties to other agencies, such as farmer-entrepreneurs, small-scale seed companies and non-governmental organizations (NGOs). Revenues from government seed sales and services will cover their costs. After just two

seasons this new government unit is marketing rice, sorghum, maize, millet, cowpea, groundnut and pigeonpea seed. This approach encourages and builds on the strengths of existing local seed systems and communities, rather than bypassing them.

To help counter the problem of free seed giveaways following disasters and conflicts, Catholic Relief Services, an ICRISAT partner, has devised a 'voucher' system. Investors provide farmers with vouchers they can use



*A commercial seed salesman explains the advantages of improved seed in rural Mozambique.*

to buy seed from local or commercial seed sellers at 'seed fairs' organized by NGOs. The seed sellers redeem the vouchers for cash from the aid agency, reinforcing local seed systems. Influenced by these findings, the European Union has decided to refrain from seed giveaways in future crisis aid situations in eastern/southern Africa.

A major opportunity lies in helping farmers tie into growing urban and export markets. An innovative effort of the National Smallholder Farmers' Association of Malawi (NASFAM) unites 100,000 small-scale producers in one of the poorest countries in the world. NASFAM has established a financially self-sustaining quality seed production program serving its members. The first shipment of high-quality groundnuts was accepted by UK and South African buyers over the past year. ICRISAT research has been pivotal in helping control the risk of aflatoxin in these groundnut shipments, a toxic contaminant that is unacceptable in even minute quantities for export. This success has

led to repeat orders from the overseas buyers, triggering increased demand from NASFAM farmers for improved seed.

Yet another avenue for getting improved seed to smallholders relates to the hybrid variety breeding programs I mentioned before. The extra yield delivered by hybrids more than pays for the additional seed cost. The annual repeat-business model enabled by the hybrid approach will attract the larger commercial seed companies who have the skills and resources to carry out the exacting process of hybrid seed production.

These successes are opening new doors for us and our partners. We are coordinating a new regional effort called Sustainable Commercialization of Seeds in Africa (SCOSA) with support from USAID and other investors. We cordially invite you to join this exciting effort to reduce hunger and poverty through innovation in seed delivery systems for Africa. Please email me for more information. Together, we can help millions help themselves.



## Diversity Delivers the Dryland Goods

The world has grown accustomed to painful images of Africa's drylands. Droughts, famine, utter poverty, fleeing refugees... will it ever end?

The media focuses on disasters, because that grabs attention. But at ICRISAT we know there is another side to the story. The peoples of the drylands want a better future. They want to cultivate their lands in more productive and sustainable ways, and to rehabilitate those lands that are degraded.

We think this dream is achievable, if we think differently – and positively – about the potentials of these lands. The drylands are favored with ample sunshine, fewer pests and diseases, and an easier terrain to cultivate or graze compared to wetter areas. Though dry on the surface, many dryland areas are also blessed with large water resources, either underground or in rivers that pass close to large urban markets.



Yes, drought is an ever-present threat; but if we look outside the box of current farming systems, we can find ways to mitigate drought risk and raise incomes and profitability. With our partners, the national programs across Africa and Ben-Gurion University's International Program for Arid Land Crops (IPALAC), and through support from the CGIAR members and additional support from Finland, USAID and the World Bank, we are developing novel farming systems that we believe offer a new future for dryland Africa. I would like to briefly outline a few of these new options and why we are excited about them.

## Dryland enrichment

There are three main ingredients to a model we call the 'Sahelian Eco-farm', which can multiply dryland farmers'



*By improving soil fertility and rainfall capture, crops like watermelon can thrive even in the sandy soils of the Sahel.*

net income by a factor of six while restoring soil health. Because dry areas have less plant vegetation on the surface, their soils tend to be very low in organic matter and depleted of nutrients. We are finding that we can correct these deficiencies by planting hedgerows of special drought-tolerant, nitrogen-fixing trees such as *Acacia coleii*. The leaf litter as well as decaying roots add organic matter to the soil and also reduce wind erosion and increase water infiltration. Small amounts of fertilizer complement the organic matter, and crop yields are boosted substantially.

Water is the second key ingredient. We construct small bunds, or dikes across the slope, in a way that channels rainwater towards high-value trees such as Pomme du Sahel (*Ziziphus mauritiana*) which yields fruit, firewood and forage. This water-harvesting technique captures water that runs into the field from higher land as well, multiplying the amount of rainfall that effectively reaches the farm; and the healthier root systems of the crops and trees grow deeper and spread wider to capture more of it.

The third crucial ingredient is crop diversity. By adding high-value specialty crops such as fruit trees, vegetables, fibrous grasses, herbs and medicinals to the traditional cereal-based systems of the drylands,

farmer's incomes are greatly increased and stabilized. In addition to cash, diversified systems create a more nutritious household diet and provide remunerative labor opportunities as well as valuable byproducts like firewood, fiber and fodder. Naming just a few examples, the seeds of *Acacia coleii* can partially substitute for costly fishmeal in chickenfeed; roselle (*Hibiscus sabdariffa*) has a large export market as a food colorant; *Andropogon gayanus* grass stems are in wide demand for roofing and mats; and local leafy vegetable species add vitamins to the diet as well as cash to the wallet.

Higher incomes can also be wrested from some of our traditional crops through plant breeding. Disease and drought-resistant pigeonpeas yield abundantly and are exported to India, providing farmers with a life-saving backup when droughts wreck their maize crops in eastern and southern Africa. Groundnuts have export potential to Europe when aflatoxin is controlled, as in our Malawi partnership. Cowpeas (which we are studying in partnership with IITA) can earn farmers three times more than millet, and their stems are in high demand to feed hungry livestock across the Sahel.



*The Sahelian Eco-farm stays green long after the rains have ended. High-value Pomme du Sahel fruit trees thrive because rain water channeled to them by the bund system continues to be tapped by their deep roots. Improved cowpeas between the trees grow on residual moisture. Greyish leaves surrounding the field are the soil-building tree *Acacia coleii*.*

Diversifying cropping systems is not as simple as just planting new types of seed; the post-harvest processing, transport and marketing systems must also be transformed from an artisanal level into a commercial enterprise. This requires mechanisms for farmer cooperation, new learning and technology, strategic partnerships with the private sector, and enabling policies. We are working on all these aspects in a holistic, systems approach.

## Bringing drylands back from the dead

You do not need to look far in dryland Africa to see barren areas that are eroded and capped with crust, or are so nutrient-impooverished that crops are weak from malnutrition, or meager rangelands grazed by stunted, bony cattle. We are finding that some very hardy indigenous trees can grow under such difficult conditions and can restore the soil over time through their root activity, biomass and nitrogen fixation.



*Trainees learn how to graft higher-value mango stems onto locally-adapted rootstocks.*

But they must be profitable in order to motivate people to plant them. An example is *Acacia senegal*, which produces the commercial product ‘gum arabic’, which is exported globally. We are selecting high-yielding trees to be grown by communities in plantations that return a good income while renovating ruined lands. Other promising trees being studied include tamarix (*Tamarix aphylla*), mango, jatropha (*Jatropha curcas*), boschia (*Boscia senegalensis*) and more.

## Leveraging water

Most African cities are located near a major water supply, and high-value vegetables are grown nearby by thousands of small-farm entrepreneurs in hand bucket-irrigated ‘market gardens.’ These gardens are strategic intervention points for development, because irrigation opens many agricultural opportunities, and cities are gateways to regional and international commerce.

We have developed a low-cost system called the ‘African Market Garden’ that greatly reduces the drudgery of hand-carrying water while increasing the water use efficiency of these gardens through gravity-driven drip irrigation. Combined with improved vegetables interspersed between date palms, the African Market Garden is a real income accelerator. Our

studies suggest a seven-fold increase in net income without the date palms, or fifteen-fold when date palms are added to the system.

Vegetables can be extremely profitable when soil fertility and water supplies are improved as in the African Market Garden model. We are selecting varieties of lettuce that will not bolt (flower) too early in the warm tropics; tomatoes that will not drop their flowers because of high night temperatures during the rainy season, when market prices are highest; and high-value onions and peppers, along with date palms that can thrive in the climate of the Sahel. Many other vegetables can be grown in these warm, sunny climates. This work benefits from close collaboration with the World Vegetable Center (AVRDC) and the Global Horticulture Initiative including a joint staff appointment; and partnership with the University of California at Davis.

## Beyond the box

Basic food grain production will continue to be vital, but farmers can complement it by diversifying parts of their farms to grow their way out of poverty. By thinking beyond the box of the over-simplified agricultural systems that prevail today, we can overcome pessimism and help the peoples of the

dryland tropics create what we call a 'grey-to-green revolution', converting a grey hopelessness into a prosperous landscape.

In an effort to keep this letter short, I feel I have barely touched on many ideas that

are worth delving into far more deeply. But I hope I have whetted your appetite. I would welcome your comments, feedback and ideas about new systems and crop diversification in the drylands, for there is much yet to learn, and it is a road best travelled together.



## Don't Desert Drylands!

The United Nations declared 2006 as the International Year of Deserts and Desertification (IYDD). June is full of IYDD events, which is why I'm focusing on the CGIAR's role in combating desertification in this letter – and why I've chosen to echo the UN's catchy slogan for World Environment Day (June 5), "Don't Desert Drylands!"

Progress against desertification has been hampered by several myths. The problem began with calls of alarm

over 50 years ago that the Sahara was spreading southwards, swallowing towns and farms in its wake. The images were frightening, but alas – they could not be substantiated later by careful science. Important stakeholders became disillusioned by this false alarm, and it was difficult to regain their confidence and support later to tackle the very real problems of dryland degradation. This illustrates one of many reasons why good science needs to be a

close companion of major sustainable development campaigns.

And that is what the CGIAR Centers and their partners have been contributing for nearly three decades, especially since ICRISAT and ICARDA were established to focus fully on the drylands. ICRISAT has closely partnered with the United Nations Convention to Combat Desertification (UNCCD) since its inception in the early 1990s, and brought three additional Centers (ICRAF, ILRI, TSBF-CIAT) together with nine African countries to form the Desert Margins Program (DMP). The DMP has become the CGIAR's flagship program against desertification in Africa, working to better understand land and biodiversity degradation, and to find ways to counter them.

Through DMP in partnership with CIAT-TSBF and FAO we have been advancing our microdosing work, which confronts two other myths about the desertification-prone drylands: that water is always the main constraint, and that fertilizer is too risky. We have also challenged the conventional belief that only low-value grain crops are suitable for the drylands, through our work on crop diversification. All these myths keep farmers mired in poverty and food insecurity, as I discussed in previous letters which you can



find here: <http://www.icrisat.org/enewsletter.htm>.

Building on the DMP's success, this year we proposed jointly with ICARDA a major new initiative: a global CGIAR Systemwide Program we call 'Oasis'. We chose the name Oasis because it reflects our optimism that science-based development can cut through the myths and despair and help dryland communities create a much brighter future.

I am pleased that eight Centers have so far joined as Oasis partners. The DMP will continue as a cornerstone of Oasis in Africa, linked to work across the globe done by CIAT, CIMMYT, ICARDA, ICRISAT, IFPRI, ILRI, WARDA and their many partners. Oasis will help these Future Harvest Centers build synergies and take the holistic, integrated-ecosystem approach that is essential for overcoming the complex problems of desertification.

The UNCCD has commented that desertification is, at its core, a human development problem, and to tackle it we need to attack poverty. IFPRI, also

an Oasis partner, carries out world-class research on policies to foster sustainable livelihoods and development. IFPRI will help Oasis tie the pieces together, investigating sustainable development pathways and policies that will work in these zones.

Oasis also links ILRI's strong understanding of livestock and rangeland management methods and policies, which are a vital complement to ICRIAT's cropping systems expertise, since crops and livestock interact closely in the drylands. The degradation of rangelands and their wealth of wildlife and plant biodiversity is a pressing global environmental issue in which ILRI plays a leadership role.

One of the UNCCD's major constraints has been a lack of techniques for adequately measuring land degradation, especially on large areas. Some have estimated that desertification has already damaged

70% of the drylands, whereas the recent Millennium Ecosystem Assessment indicates a 10-20% range. That's a big difference, and needs to be clarified. Oasis brings in ICRAF's leading-edge technology for estimating land quality from satellite data using a technique called near-infrared reflectance spectroscopy. This enables the CGIAR to contribute importantly on defining the desertification problem and its extent.

In addition Oasis links the crop improvement and germplasm conservation capabilities of both tropical and temperate-zone Centers. CIMMYT has developed drought-tolerant maize that is about 30% higher-yielding along the moist edge of the drylands in southern Africa. ICARDA and CIMMYT jointly breed dryland wheat for central and western Asia and northern Africa, and are doing leading-edge drought resistance gene work. At ICRIAT we've contributed to varieties grown on a million hectares in dryland Africa, and have had major impact in dryland Asia as well.

And though few think of rice in the drylands, that is yet another myth that needs to be laid to rest. Rice is an important irrigated crop along the major river systems of West Africa, and in low-lying, heavy-soil dryland areas such as the Lake Chad and Lake Victoria basins. WARDA varieties are widely grown in these areas,



*Crops, livestock, people and the land are all interdependent in the drylands.*





*ICRISAT strengthens national programs in advanced skills such as geographic information systems.*

and we are glad they'll contribute their rice breeding and inland-valley management expertise to Oasis.

Along with all these complementary capabilities, the Oasis Centers also have some areas of overlap that hold much potential for joint work to create greater critical mass. Several Centers and their partners work on dryland soil science issues, for example. Many of the principles and tools of plant breeding are also similar across crops. Farmer-participatory research is a third area in common. Through Oasis we will share knowledge and expertise to make the sum greater than the parts.

Although I am mainly describing the Centers' work here for brevity, I want to emphasize that none of them operates in a vacuum. They are

closely tied to national, regional and international partners in the public, civil society, non-governmental and private sectors. Oasis is, in a sense a "meta-partnership" that interlinks these primary networks. The Center partnerships will drive the agenda, but Oasis will make it easier and more productive for them to work together.

No, we at ICRISAT will not 'Desert the Drylands'. On the contrary, we are forging ahead even more strongly, with well-rounded science through Oasis. I invite you to visit the Oasis website to learn more about the capabilities it brings to the table ([www.oasisglobal.net](http://www.oasisglobal.net)). I would welcome your suggestions and feedback, and certainly your support to make it a great success.



*Millet is life for millions in the drylands.*



## Biofuel Crops: Power to the Poor

Developing nations are looking towards biofuels to help reduce their spiraling foreign oil import costs, and to mitigate pollution and global warming. The drylands, often neglected compared to more favorable areas, can contribute importantly to a bio-fueled future. Our challenge – and opportunity – is to ensure that the dryland poor are not left behind.

### Bio-ethanol: an idea whose time has come

Contrary to common belief that massive subsidies are needed to promote bio-ethanol, it is now price-competitive with petrol (gasoline) in India without subsidies, due to recently skyrocketing petrol prices. This is the case even after adjusting for energy-equivalency

(one liter of petrol has the same energy content as 1.5 liters of ethanol). India is targeting a 10% blend of ethanol in its national petrol supply.

The constraint is not the cost of ethanol production; it is the supply of raw materials. This is where ICRISAT and partners come in.

### *Sweet, sweet sorghum*

Most bio-ethanol in India is produced from the molasses left over from the refining of sugar from sugarcane, but the supply of molasses is insufficient and not reliable enough for costly ethanol production facilities that need to keep working around the clock to pay off. We are excited about the potential of a little-known dryland crop, sweet sorghum, to help fill this supply gap. 'Sweet' varieties of sorghum store large quantities of energy as sugar

in their stalks, while also producing reasonable grain yields.

Sorghum, like sugarcane and maize, exhibits  $C_4$  metabolism – making it more efficient at converting atmospheric carbon dioxide into sugar than most plants. As a dryland crop, sorghum requires far less water than costly irrigated sugarcane, making it more accessible to the poor. The juice squeezed out of sweet sorghum stalks contains about 15-20% sugar that can be fermented into ethanol more cheaply than from sugarcane molasses – and with even greater energy savings compared to maize grain, which has to be hydrated and converted from starch to sugar before it can be fermented.

India's National Research Centre for Sorghum (NRCS) has long recognized the potential of sweet sorghum



*Sweet sorghum: breeding biomass for biofuel.*



*After crushing the stalks are excellent for cattle fodder or to fuel the ethanol production facility.*

and has developed excellent open-pollinated varieties and some hybrids. Our complementary contribution has been the identification of high-sugar parent lines for hybrid breeding from our global germplasm collection (another payoff from that immensely valuable resource). Hybrids are also less photoperiod sensitive so they can be grown year-round, smoothing out supply variations for the ethanol production facilities.

### *Making it happen*

We are stimulating public-private collaboration to move sweet sorghum from a good idea on the shelf, to impact on the ground. Our hybrid sorghum program receives substantial support from the private sector (30 seed companies) through our innovative Hybrid Seed Consortium, so the seeds are moving quickly through the research-to-development pipeline.



*ICRISAT works closely with Rusni to deliver on sweet sorghum's promise.*

At ICRISAT headquarters in Patancheru, India, we've also formed a public-private partnership with Rusni Distilleries (P) Ltd. Rusni ensures that seeds of the highest-sugar sorghum varieties identified by ICRISAT and NRCS reach farmers so they can increase their productivity. Rusni also helps farmers by transporting the stalks from farms within a 30 kilometer radius of the plant, and providing more distant farmers with technologies to crush the stalks and reduce the juice into syrup that can be moved cost-efficiently to the ethanol production plant. Lessons we are learning from this partnership will enable the technology to scale up faster and more widely in the coming years.

### **Bio-diesel**

Forty percent of India's oil imports are consumed in the form of diesel fuel, and demand is rapidly growing. The nation has adopted similar blending targets as for bio-ethanol (10%). Bio-diesel is even more environment-friendly than bio-ethanol because it requires less energy to process. It is also much less polluting than fossil-fuel diesel.

As in the case of bio-ethanol, the biggest constraint for takeoff of the bio-diesel industry is insufficient supply of the raw material. To fill this gap, vast wasteland areas, estimated at 38 to 187 million hectares in India, that include areas suitable for dryland-hardy



*Jatropha* grows vigorously in dryland Africa; note the oil-rich fruits.

bio-diesel crops can be made available to local communities. While providing an income-earning opportunity for the poor, these perennial tree and shrub crops also help rehabilitate these lands by building the fertility of their soils.

Two contrasting dryland species are especially interesting: *Pongamia pinnata*, a leguminous tree adapted to wetter wastelands with problem soils; and *Jatropha curcas*, a more drought-tolerant shrub adapted to

well-drained wastelands and widely grown as a homestead boundary plant in the Sahel. Both produce fruits containing about 35% oil suitable for bio-diesel.

Women are the main cultivators and processors of bio-diesel crops at the village level. ICRISAT is working with poor women united in self-help groups to start *Pongamia* enterprises in remote tribal areas of Andhra Pradesh, India, and working with

India's national research system to identify high-oil varieties as well as better cultivation methods.

India is also promoting *Jatropha*; it is grown along rail lines and the oil is blended with petro-diesel to power trains. *Jatropha* is also widely grown as a hedgerow boundary plant in Indian and African villages. We are exploring the genetic variability in *Jatropha* on both continents to find higher-oil types to increase its income-earning potential.

## A future of possibility

Some question whether biofuel crops will compete for land with food crops, driving up food prices. To be sure, there are risks; however we look at this issue differently.

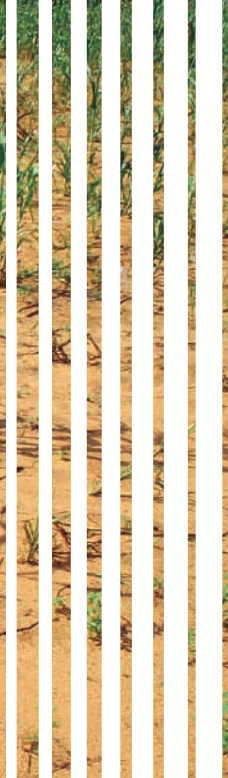
The dryland poor need food to eat, but they also need opportunities for economic growth if they are to escape poverty. Sorghum production in India has been declining for many years due to urban preferences and subsidies for rice and wheat, lessening economic opportunities for dryland agriculturalists. The same trends will probably develop in Africa in decades to come. Increases in area sown to corn or sugarcane for ethanol, in contrast would take the

most valuable, fertile lands out of food production.

Through research-for-development, we can help transition the sorghum enterprise from a human food to a cash crop for bio-ethanol as well as producing grains and stalks that feed humans and livestock. We can help rural villages gain greater self-sufficiency in energy production through bio-diesel crops. The benefits are multiple and significant: easing poverty, reducing air pollution, mitigating global warming, and rehabilitating degraded wastelands.

Biofuels are a major emerging trend that can have a large impact on dryland development. Now, in the early stages, is the time of greatest opportunity to ensure that the poor capture a large share of the benefits. Raw materials are a key constraint that we are helping to overcome in a pro-poor manner through our dryland crops expertise and partnerships with investors, governments, non-governmental organizations and the private sector.

Many twists and turns still lie ahead of us on this road, but I am confident that with your support and partnership we will be able to power a better future for the drylands through biofuels.



## Climate Change: Back to the Future

Most scientists now agree that global warming is inevitable, and that it will have major impacts on climates worldwide. It will take a long time to reverse this trend, and in the meantime adverse impacts on the poor in developing countries will be especially harsh. We must help them.

The poor can also help us, because they have been there before. Dryland inhabitants have always been adjusting to large variations in climate, both short and long-term.

By looking back, we will find clues to our future.

We also view *current* climatic variability as a learning opportunity – in a sense, as a dress rehearsal for future climate change. By helping the dryland poor to cope better with current climate variability, we help them better prepare for the future.

### What farmers think

At ICRISAT we are learning from poor land-users through village-level socio-



*Squall lines that bring unpredictable deluges to the West African drylands are the embryos of the Atlantic hurricanes that later hit the Caribbean and North America.*

economic studies, land-use surveys, and 'farmer field schools.' We also involve farmers in our plant breeding research to learn about the plant traits that they value most.

Villagers in India and in Southern/Eastern Africa, for example tell us they have noticed changes in the amount and irregular timing of rainfall in the past 30 years; whereas rainfall has been slowly increasing in Africa's Sahel region over the past two decades (interspersed by punishing droughts). In all three regions, farmers have adjusted cropping practices and the varieties of crops that they grow. We should work with them to build on their solutions.

## More from more

We must help farmers prepare not only for risks, but also for opportunities. Climate prediction models do not yet tell us with great certainty whether rainfall will increase or decrease in many dryland areas, or between seasons. Higher rainfall and in some areas warmer temperatures could even enable increases in agricultural productivity, but may also bring diseases, pests and invasive species.

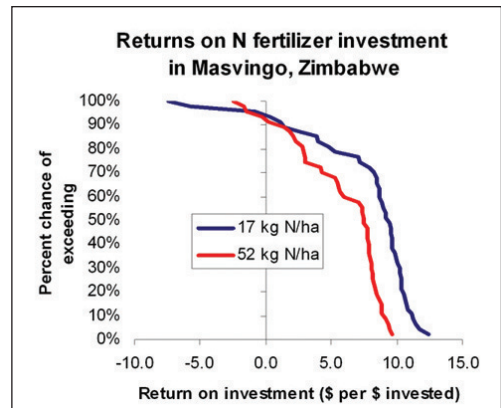
To help farmers get a better handle on these uncertainties, we've partnered with meteorological services and leading climate modeling researchers worldwide. We blend their knowledge with our expertise on tropical dryland



farming systems using climate-driven risk analysis. This involves the use of leading-edge tools such as weather-driven crop simulation models, spatial weather data generators, and seasonal climate forecasting models.

We should also seek opportunities to make better use of natural resource assets, pools and flows. Take water, for example. Much of the rain that falls on the drylands, paradoxically, is 'wasted' from a farming point of view – water that is never picked up by plants because it comes in flood surges, or because soils are surface-sealed and unable to absorb it, or because crop roots are underdeveloped due to malnutrition and thus unable to take up the water efficiently from the soil. We are helping farmers devise ways to manage landscapes, soils and crops so that more of the water and nutrient resources are stored and used more efficiently and over a longer time period. This will prepare farm families to better endure the greater variability of rainfall that many expect in the future.

Likewise, we can get more from more by improving economic and social resource assets, pools and flows. Co-learning with farmers and research on how they innovate helps build social and knowledge capital, and extends their benefits more widely. These studies help us improve institutions and cooperation mechanisms such as community self-

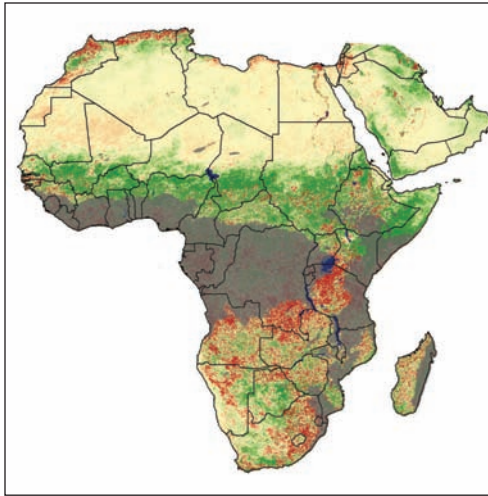


*A simulation model (APSIM) was used to predict how maize would respond to fertilizer in a drought-prone, variable-rainfall area of Zimbabwe (Masvingo) using rainfall data from a 46-year period (1952-98). The model found that farmers were highly likely to enjoy a positive return on investment in nearly all years, gaining a 10-fold return in about half of the years when using microdoses of just 17 kg N/ha, exceeding the financial returns obtained from the conventionally-recommended rate of 52 kg/ha.*

help and joint credit associations, micro-credit from socially-conscious lenders, market opportunities that diversify risk, and affordable insurance against severe drought. These increase farmers' resilience in the face of both current climate variability and future climate change.

## Learning from genes

Farmers have also been astute in their development and use of special breeds of livestock, crops and trees that are genetically engraved with



Satellite data illustrate changing vegetation trends across Africa, especially the re-greening of the Sahel since the mid - 1980s. Green: increasing vegetation; red: decreasing vegetation. Vegetation changes may reflect human activities as well as climatic variation. Data are differences between the periods 1985-1992 and 1996-2003 for averaged normalized difference vegetation indices (NDVI). Source: Data processed by ICRISAT from the Global Inventory Modeling and Mapping Studies (GIMMS), University of Maryland.

astonishing adaptive traits, many of which we are yet to decipher.

They know that different plants vary for soil fertility requirements and tolerance to flooding, heat, insects and diseases, pressures that are all likely to be affected by climate change. Natural and farmer-aided selection have favored the evolution of remarkable traits such as 'photoperiod sensitivity', which ensures that the plants mature



ICRISAT helped farmers in the poor village of Pongguda become the first in India to sell carbon credits (147 tons of carbon worth US\$645). The credits, bought by the World Bank were earned by growing Pongamia trees that store extra carbon while yielding bio-diesel, yet another additional income source.

around the same calendar date each year regardless of planting date. This trait is valuable because farmers can only plant after the rains begin in earnest – a date that is unpredictable and varies widely from year to year.

Farmers insist on planting mixtures of genetically-different plants and varieties because they know that if a stress knocks out one genetic type, another is likely to survive it. They take this even further: they not only diversify varieties within crops, but they also grow a range of different crops, including trees that disrupt winds and moderate the baking heat and pounding storms that will increasingly punish crops as climate change kicks in.



*Farmers in the Sahel protect trees such as Faidherbia albida that tap deep water tables to provide shade and dry-season fodder for livestock, which in turn produce manure that improves crop production. Trees also moderate the land surface micro-climate and reduce wind erosion.*

There is a lesson here for our monocultured world. We have been narrowing genetic diversity to fit our industrial agriculture over the last hundred years. We need to do a better job of protecting and utilizing our dwindling biodiversity assets, because with climate change on the way we will need them more than ever.

We are carrying this lesson forward to help farmers expand their agrobiodiversity and marketing options. By increasing the number of high-value crops, trees, shrubs, and herbs available for cultivation, and by growing them together in more diverse farming systems, farmers will be less vulnerable to climatic and economic shocks.

### **Together we can**

To magnify our capacities and increase momentum on the crucial

topic of climate variability, we are building a coalition with the Soil-Water Management Network of the Association for Strengthening Agricultural Research in East and Central Africa (ASARECA) and 15 national, regional and international organizations. This consortium is endorsed by the New Partnership for Africa's Development (NEPAD) and its Comprehensive African Agricultural Development Plan (CAADP).

Investors have a key role to play too, because they make our work possible. Some say we owe it to the poor – after all, they are not the ones causing climate change. But they *are* helping us find solutions. Through increased investment and the use of modern scientific tools we can accelerate the pace and scope of research – helping the poor not only to survive, but to thrive.



## Defeating Dryland Risk

It is commonly said that drylands are the riskiest environments for agriculture. But if dryland agriculture is so risky, why do so many engage in it? The simple answer – that they have no choice – is not enough. By understanding how they became entangled in risk, we might find ways to get past it.

### Getting from there to here

Traditionally, dryland agriculturalists managed drought risk by avoiding it. If

they could not bring rain to their farms, they brought their 'farms' to the rain – by herding their livestock to greener areas. This nomadic pastoralist strategy required vast areas of land, occupied by relatively few human beings.

As human populations increased, dryland inhabitants evolved agro-pastoralism, a combination of crop farming and animal herding that is still common today. Crops provide additional food and income in good years, while the mobile herds provide

resilience in drought years. Income is earned from sales of small surpluses of food to growing towns, which provide specialty goods and services that increase the quality of rural life.

As populations increase further, towns grow into urban areas and lands become privatized. Agriculturalists can no longer escape drought risk through fallowing or livestock mobility. Some dodge drought by taking up dry-season urban occupations or by leaving the farm entirely. Others invest urban-market income into irrigation, fertilizer and other inputs, reducing drought vulnerability.

### Stuck in a risky rut

Those are the happy endings. Unfortunately, many are not able to

clear away the risks that block their pathways to prosperity. When they get back onto the path, drought knocks them off again into the rut of poverty. They cannot afford to irrigate, fertilize, or educate their children to help them overcome drought risk. Instead, they lose their animals, their crops fail, and they go hungry. And as the new IPCC report tells us, climate change will likely make things worse, especially for the drylands of Africa and Asia.

How can research-for-development practitioners help those who are trapped to find *sustainable development pathways* that lead either to sustainable agricultural intensification, or to exit from agriculture? Each step must be clearly attainable, and must provide

Village-level responses to drought in two states in India (446 households in six households surveyed).

Parameter/strategy	Average, Andhra Pradesh	Average, Maharashtra
Number of drought years in last ten	5	3
Average income shortfall from drought (%)	50	23
Percentage of farmers coping, by:	82	36
Borrowing money	38	15
Selling assets	9	2
Shifting to nonfarm work	29	37
Reducing expenditures	6	27
Migration	15	2
Reducing input use	4	10

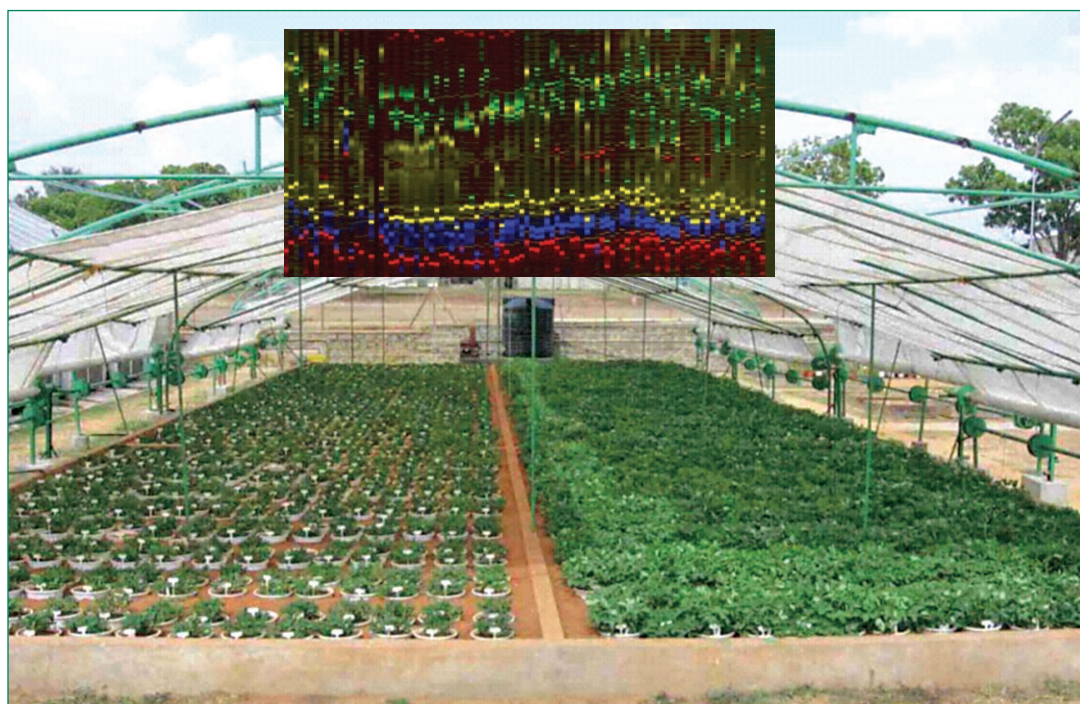
incentives to take the next step, with risk management controls in place. One size does not fit all; multiple options are needed for different environments and socio-economic settings. Some examples are below.

## Stepping stones to secure futures

Weak plants and animals are more susceptible to drought, and thus impart high risk to farmers. Plants and animals can be drought-hardened by correcting soil and animal nutrient

deficiencies, breeding resistance to diseases, and matching genetic adaptation to the environment. Research has found affordable ways to do all these things.

Shortages of water and nutrients can be eased by tightening natural resource cycles through tree-crop-livestock synergies. Tree roots ensure that early and late-season nutrient surges are captured and water tables are tapped, and recycled through root biomass and leaf litter. Crops capture nutrient surges triggered



*ICRISAT scientists compare plant performance under glasshouse-controlled drought, to gene patterns visualized from high-throughput molecular genomics data (inset), mapping stress-resistance genes for more effective drought resistance breeding.*

by early rains, and stem biomass is recycled through livestock manure. Livestock graze biomass beyond the farm gate and deposit it at home to raise crop yields.

Integrated water-soil-nutrient management holds particular potential. Low-cost land-forming interventions such as small basins and ridges for on-farm water harvesting retain and concentrate scarce water to reduce risk when the high costs of conventional irrigation development are not affordable. Watersheds are natural concentrators of water and nutrients, and their integrated management by communities is reducing risk on a large scale in Asia, and is likely to spread to Africa in the future.

More diverse crops and livestock reduce the risks associated with failure of any single component. Similarly, more diverse livelihood options, such as off-farm work help farmers protect themselves against farming failures. Such off-farm linkages also help them (or, equally important, their children) transition into possible full-time urban employment, reducing population pressure on the fragile drylands.

Smallholder-affordable inputs such as fertilizer microdosing (see “What ICRISAT Thinks about Niger’s Hunger Crisis”) that aim for economically-optimum responses can deliver large returns on small investments, rather than seeking biologically-maximum responses through unprofitably-high input use as advocated in the past.



*Livestock recycle crop residues through manure in Western Kenya, reducing risk.*

Increased feed supplies through fodder banks and the sale of feed supplements, along with affordable animal health care can fortify animals to withstand the stresses of drought.

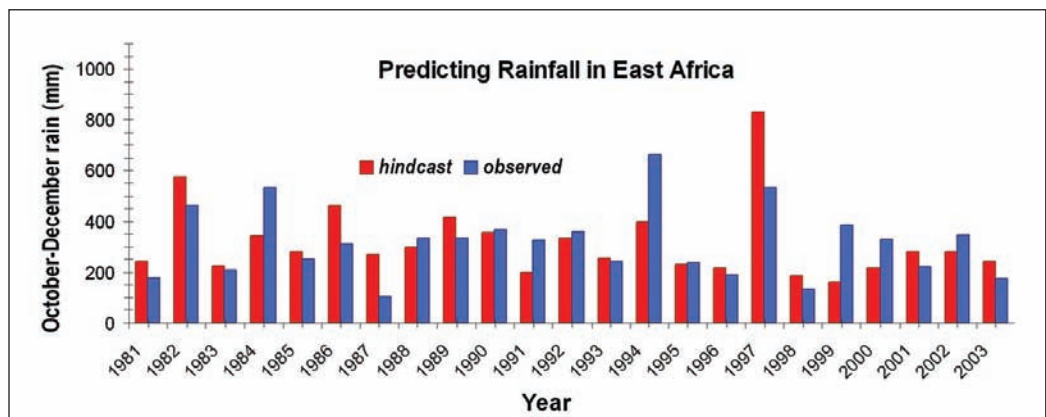
## Investing against risk

Financial risk reduction is also vital, but poor smallholders lack access to formal bank credit or insurance. Micro-credit facilities and loans, such as the ‘warrantage’ system that FAO is spreading in the Sahel that uses farmers’ crop harvest itself as the collateral, enable the poor to act as investors, capturing higher grain prices and reducing interest costs.

Efficient, risk-controlled channels for inputs and outputs are essential to minimize input price inflations and output price collapses. Fertilizer and

seed can be sold in small packets that fit the needs and financial means of poor smallholders. Knowledge also reduces risk and increases rewards; rural retailers are a vast ready-to-go network for information-sharing as well as for disseminating inputs and collecting outputs. Emergency grain reserves can reduce the risk of wild price swings that leave the poor unable to buy enough food to eat.

Research-for-development institutions, including policy and technical initiatives should help agriculturalists capture higher-value markets that are emerging as the drylands join the global trend towards urbanization. This raises rural incomes rather than ceding markets to foreign exporters or allowing them to remain unexploited.



*Rainfall models can predict droughts or wet years in some areas, such as the October to December rainy period at Machakos, Kenya. Models are developed by testing past data (hindcasting) versus observed rainfall. Model developed by the International Research Institute for Climate and Society (IRI) at Columbia University, USA in collaboration with ICRISAT.*



## Predict and prepare

Drought prediction and preparedness can greatly reduce risk. If herders knew when drought risk was high, they could sell some of their animals before prices collapse because too many are rushing to sell the animals that they cannot sustain. Farmers could reduce plantings that are likely not to pay off due to drought, focusing their efforts instead on their least-risky fields and lower-risk off-farm activities. Emergency relief agencies could better plan and prepare their assistance. New technologies in remote sensing, GIS, crop modelling and mapping are increasing forecasting and early-

warning capabilities, as well as market supply and price forecasts, all of which can help take affordable insurance against drought from vision to reality.

## Surer paths to prosperity

Ultimately, pathways to less-risky futures must be traversed by farmers themselves. We can help remove some roadblocks, but we cannot make the journey for them. But neither should we construct a road that requires impossible leaps from one stepping stone to the next. By building achievable, rewarding steps, we can help the poor leave risk-induced poverty far behind.

**Potential predictability of seasonal forecasts in Africa.**

Region	Rainfall period	Potential predictability
West Africa	July to September	High
East Africa	October to December	High
East Africa	March to may	Low to medium
Southern Africa	January to March	Medium
North Africa	December to March	Low



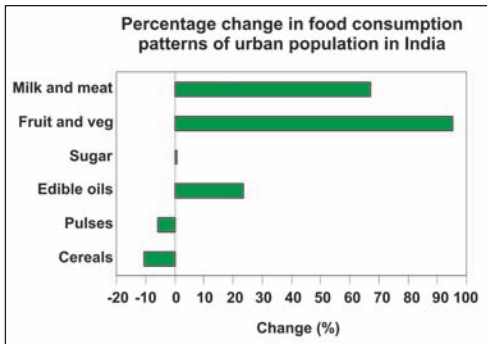
## Hope from High-Value Crops

Development experts agree that poverty is the root cause of most hunger and vulnerability in the drylands. Most poverty is in the rural areas, where agriculture is the main income-earning option. But farming low-value grain crops on just a hectare or two does not earn enough to erase poverty.

Cereal grain prices have fallen for decades, which is good for consumers but puts pressure on dryland smallholder farmers. They

cannot expand their cropped area, mechanize their operations or raise their input levels to compensate for falling prices, in the way that large-scale farmers can. Subsidies for foreign producers have also undercut local agriculturalists' ability to earn a living from grain farming.

Dryland smallholders need additional options that work to their comparative advantages, generating high value from mostly manual labor on a small land area.



*Urban India dramatically shifted its food consumption pattern between 1983-1999, spending proportionately more on fruit and vegetables, milk and meat, and less on cereals and pulses. Source: Dev et al. 2004, cited in Parthasarathy Rao et al. 2006. ICRISAT Policy Brief 9.*

## Urban demands, rural rewards

Urbanization is gaining momentum across the drylands of Asia and Africa.

Urban centers create new markets, and with higher incomes demand more diverse diets. Fruits and vegetables are especially promising because of their high market volumes and value. Fruit and vegetable cultivation can multiply farm incomes severalfold compared to cereal grain cultivation.

## Vegetables nourish rural economies

Facing severe land constraints due to high populations, smallholder Asian farmers have much experience with high value vegetable and fruit crops. ICRISAT partners closely with the World Vegetable Center (AVRDC) in research to benefit Asia, and to build on that knowledge for Africa.

### Great gains

Adding watermelon to conventional maize-maize cropping systems with water harvesting triples net income in Vietnam; watermelon-mungbean-soybean adds another 70%.

Dry-season chickpea can be grown on one-third as much irrigation water as wheat in India and needs no nitrogen fertilizer, resulting in much higher profits.

By integrating fruit trees with crops and drought-hardy vegetables, the Dryland Eco-Farm system developed by ICRISAT in Sahelian West Africa quadruples the net income received from sole millet farming.

Ten trees of Pomme du Sahel (*Ziziphus mauritiana*) deliver as much value as an entire hectare of millet.

A single high-quality date palm tree yields \$200 worth of fruit per year in the Sahel.

Rainy-season tomatoes, made practical by varieties with improved fruit-set selected by ICRISAT in West Africa, attract prices five times higher than during the main dry-season harvest period.



*Farmers in dryland Thailand and China use on-farm resources to battle insect pests of vegetables: molasses in bottles to trap moths, and tobacco extract (in bucket) to be applied with irrigation water.*



Asian smallholder vegetable farmers have devised ingenious solutions for pest and disease problems. Research and development can build on these innovations through integrated pest and disease management, and help share that knowledge with other developing countries worldwide.

African vegetable farmers face a different constellation of constraints, such as shortages of labor, water control and transportation infrastructure. Vegetables require more care and investment than grain crops, so yields need to be safeguarded against drought. Good

options are available, such as water harvesting, low-cost drip irrigation, watershed management, and groundwater-sharing cooperatives.

Legume crops in ICRISAT's domain of expertise yield high-value vegetable products. In Ethiopia, fresh green chickpea pods are prized in urban areas and are an important source of income at a time when other vegetables are in short supply. In Kenya, Tanzania, Malawi and Mozambique, early-maturing pigeonpeas capture off-season high prices for green peas consumed as a vegetable.



*Pumpkins being offloaded from boats and sold along the Niger River.*

ICRISAT is finding that vegetable cultivation can especially benefit women through village self-help groups. Besides raising women's incomes, this ensures better nutrition for their families.

*Senna obtusifolia L. is a high-value medicinal and food vegetable in the Sahel; it can thrive on degraded laterite soils, justifying land rehabilitation investments.*



Many indigenous fruits and vegetables in Africa have yet to be commercialized, and are at risk of being pushed aside by the dominant global species. ICRISAT has been countering this trend by encouraging the smallholder-friendly commercialization of leafy local vegetables by women's groups such as *Senna obtusifolia*, popular for salads and sauces.

### Money growing on trees

Fruit trees also hold high-value potential. Many tree fruits mature in

the dry season, when other sources of income are few. This increases year-round employment and market value, reducing the need for young men to leave their homes in search of dry-season work.

Sloping areas are well-suited for fruit trees, which reduce erosion and add organic matter. Bunding across the slope enables water harvesting to reduce drought risk, made even more effective by trees' deep, perennial root systems. Vegetables are cultivated between the tree rows to generate



*Longan (Dimocarpus longan Lour.) fruit trees grown with soil and water conservation and fertility improvement measures (bunds, and Gliricidia, a nitrogen-fixing alley tree; with cassava intercrop) in Huong Dao watershed, Vietnam. Longan is a popular litchi-like fruit in east Asia; it is canned in syrup or eaten fresh.*



*Grafting high-yielding fruit tree shoots onto locally-adapted rootstocks adds value and income through nursery operations.*

income for the initial years before the trees begin fruiting.

At our station near Niamey, Niger, we've established a global collection of dryland fruit trees to assess their potential for the Sahel. Well-adapted varieties of mango, citrus, Pomme du Sahel, sweet tamarind, fig and grape have already been identified, and more will emerge in the coming years. Hundreds of people have been trained in nursery management techniques so that these trees can be multiplied by small-scale entrepreneurs for sale to farmers.

In addition to water-harvesting on rainfed lands, small-scale irrigation is feasible in many areas of dryland Africa. Unlike cereal crops, high-value trees and vegetables deliver enough income to pay for this investment.

As I described last year, we've developed a low-cost, water and labor-conserving gravity-drip irrigated system that we call the African Market Garden (AMG), accompanied by high-value crops and management techniques. The AMG increases tomato yields fivefold, and income is multiplied severalfold more by adding



*Water storage tanks made from cheap used oil drums (red, in background) feed water to affordable drip irrigation lines, boosting incomes from vegetables in Ghana.*

date palms and other remunerative species. Approximately 2,000 AMG units have been introduced in eight West African countries over the past four years, and the pace of expansion is accelerating.

## Navigating markets

Poor smallholders are vulnerable to being squeezed by middlemen, especially when bulky, perishable fresh produce needs to be sold. But when farmers team up to face the market together, they gain clout. More research is needed on how farmer associations can protect the interests of the poor.

Women vegetable sellers in West Africa typically collaborate to prevent price competition within their

neighboring market stalls. On a larger scale, formal institutions like the Onion Producers Association of Niger also ensure that farmers get a good deal. The Onion Producers dictate minimum prices to be paid for onions for each month of the year, and even compel buyers to pay a levy to fund Association activities. The Onion Producers run an effective market intelligence service in the major terminal points where their goods are sold. As a result, onion growers are the most prosperous farmers in the country.

As production volumes of high-value crops expand, the risks of glutting the market grow. Ways to process and preserve products for later sale, and export channels become crucial. As we identify promising new tree fruit species for the West African drylands we are also in dialogue with the private sector about processing the juice for year-round sales, including exports.

## Quality pays

Good quality is rewarded with sharply higher prices. Citrus produced in the Air Mountains of Niger fetches three times higher prices than that produced in the south of the country. High-quality onion, tomato and lettuce varieties introduced by ICRISAT and others attract a 50% price premium in several West African countries. And tropically-





*Drip-irrigated tomatoes bring quick cash while date palms build future capital in Niger.*

adapted Kabuli-type (large-seeded Garbanzo type) chickpeas that we've bred are in demand worldwide; they attract twice the price of the smaller-seeded Desi grain types. Research can uncover more treasure troves of value to benefit farmers.

## **A richer future**

I hope I have given you a glimpse of how we think we can hit poverty head-on through higher-value cropping

systems suited to the needs and capacities of the poor. The entire CGIAR recently endorsed this area of work by including it in the new System Priorities, and is considering it for Challenge Programme status. We are also closely engaged with the Global Horticulture Initiative convened by our partner AVRDC.

We'd welcome your support and ideas on ways to deliver the highest possible value to those who most need it.



## Safe and Healthy Dryland Foods

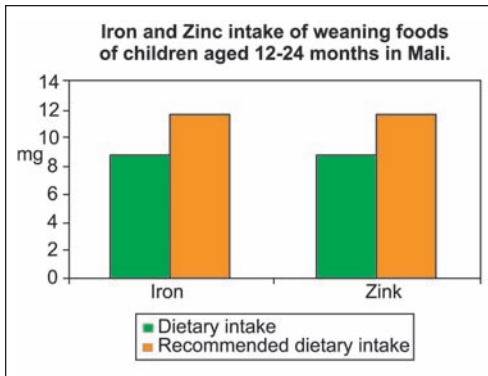
Since the 1960s, the spectre of looming mass famines galvanized the world to focus intently on multiplying the *quantities* of food grown in the developing world, with less attention to *quality*. While stunningly successful, a pernicious ‘hidden hunger’ continued to persecute the poor.

The poor have difficulty affording the varied and balanced diets they need for robust health. Many just scrape by on porridge made from low-quality grain. Besides supplying insufficient amounts

of minerals and vitamins, the cheapest grades are all too often contaminated with cancer-causing toxins.

### The scourges of hidden hunger and invisible toxins

The World Health Organization and other bodies estimate that anemia caused by iron deficiency affects over two billion people worldwide, including most poor women; that zinc deficiency, which causes stunting and morbidity affects three-quarters



or more of those in Asia and Africa; and vitamin A deficiency, which can cause blindness, growth retardation and disease susceptibility damages one-third of the developing world population. 'Aflatoxins' are toxic chemicals produced by certain fungi that infect plant foods, reducing human immune system function when consumed and causing stunting, liver cirrhosis and cancer.

The mind-boggling scale and human cost of hidden hunger and invisible toxins compels urgent attention from the world community. While a root cause of the problem is poverty (inability to purchase better, more diverse foods), hidden hunger and toxicity are also a cause of that poverty because they reduce human potential. We need to break this vicious cycle by tackling malnutrition head-on.

### ***Super-charged cereals***

Hidden hunger has recently attracted justifiable and much-needed attention

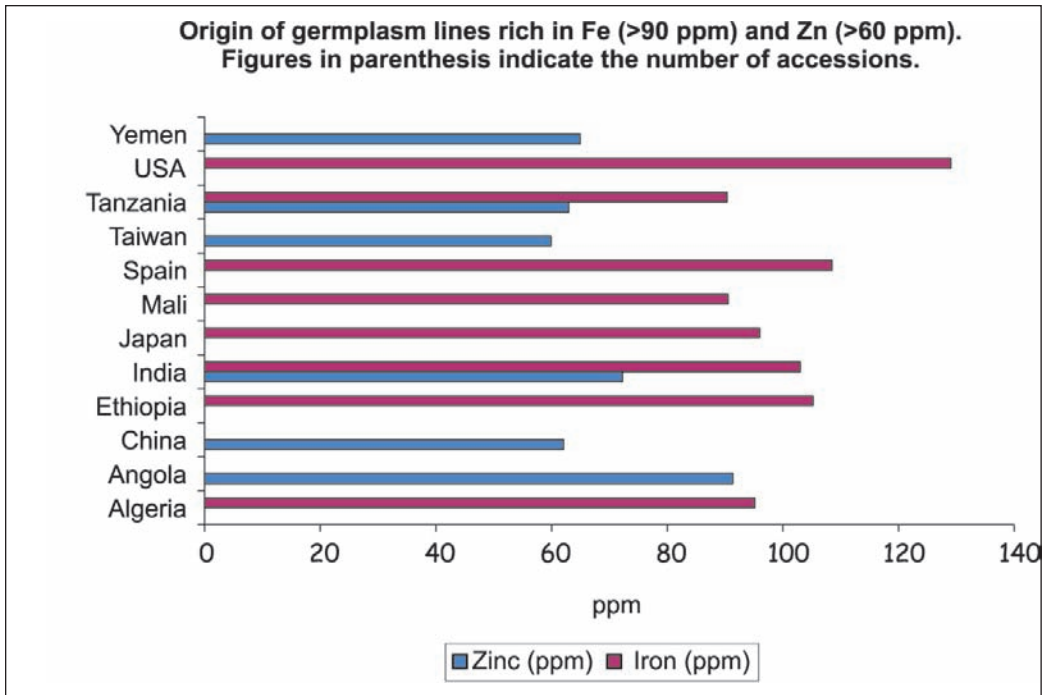
from the global development community. To breed higher nutrient levels in our mandate crops, especially the dryland cereals sorghum and millet, we participate in two major global research initiatives:

- HarvestPlus, a CGIAR Challenge Programme supported by a consortium of donors; and
- The Africa Biofortified Sorghum (ABS) project, a consortium of seven African and two American institutions funded by the Bill and Melinda Gates Foundation's Grand Challenges in Global Health program.

Begun only recently, this work has already discovered lines in ICRISAT's gene bank that have iron and zinc concentrations up to four times higher than in widely-grown varieties. It remains to be seen whether these high nutrient densities (concentrations) can be maintained as these genes are bred into adapted genetic backgrounds, but such large-scale genetic variability suggests that significant gains may be possible. Soil type where the crop is grown also has a major effect; iron-rich soils lead to iron-rich grains.

### ***The more, the better***

Even under the constraints of dryland rainfed cereal farming, much can be done to add diversity to the diet while increasing incomes. High vitamin-A



orange-fleshed sweet potato (developed by our sister center CIP) can be intercropped with rainfed sorghum; just 100 grams per day of this tasty crop meets the vitamin A need of young children. Orange-fleshed pumpkins are another option that can be planted in moist spots in the field, and have a long storage life.

Leafy indigenous vegetables such as Moringa leaves plucked from dryland trees in the Sahel have a 50-times higher pro-vitamin A concentration than millet grain. Other species often picked wild and consumed include



*Nutritious Moringa leaves sold along roadside in Niger.*

*Corchorus* spp., *Senna obtusifolia*, *Hibiscus sabdariffa* and *Adansonia digitata*. When cultivated these crops are often high income earners, helping the poor fight poverty at the same time.

## Toxic waste

Healthy foods also must be free of the aflatoxins that lay waste to human health. They are produced by the fungi *Aspergillus flavus* and *A. parasiticus* which infect many crops both in the field (often triggered by drought) and also in storage if they are not kept dry. Groundnut, sorghum, maize, spices, chili peppers, almonds, and pistachios are frequently contaminated. An integrated approach is most effective in controlling aflatoxin, including practices to avoid drought; biological control agents; fungicides; resistant varieties; timely harvesting and sorting to remove infected grains; and quick drying and dry storage of grains.

Besides harming human health in the developing world, strict limits on aflatoxin content make it difficult for many developing countries to export these crops to the developed world, cutting off income-earning opportunities. Monitoring aflatoxin contamination in food lots to certify safety can open doors to these export markets. ICRISAT developed a low-cost, highly accurate aflatoxin testing

kit based on ELISA immunoabsorbent technology.

Utilizing this kit in an integrated market-chain approach, we are helping one of Africa's poorest countries, Malawi, establish export markets to the European Union. First came the breeding of high-yielding, disease-resistant 'confectionary' groundnuts suitable for that market, and working with the government and private sector to establish the necessary seed supply systems. We then helped the National Smallholder Farmers' Association of Malawi (NASFAM) introduce a food safety assurance protocol utilizing the testing kit to meet export standards. Third, we helped catalyze a NASFAM linkage to Fair Trade importers so that NASFAM farmers garner higher prices for their produce. This



*Aflatoxin-free groundnuts exported to the UK earn precious cash for Malawian farmers.*

integrated market-chain approach is now expanding into Mozambique, Tanzania, and Kenya.

## The interconnected web of food safety, human health, and prosperity

Hidden hunger and toxins extract an insidious toll on those who will make or break the future: youngsters and the young mothers who conceive and nurture them. By increasing

food nutrient content, diversifying diets, reducing food safety hazards and increasing incomes, we can help the poor break loose from the bonds of malnutrition and toxins that prevent them from achieving their full potential.

These benefits are fundamental and long-lasting, and seem to us to be especially relevant to our aspiration to serve the world through 'Science with a Human Face'.



*Aflatoxin detection kit for seed and fruit samples.*



## Dryland Development Pathways

The comment is frequently heard that “technologies are available, what’s needed is to get them off the shelf and into use.” But will the products really sell?

It is more than just a matter of pushing the goods off the shelf and out the door. They need to be designed and deployed with a context in mind, and in consultation with prospective users to meet their needs.

Rather than viewing them as products on a shelf, we find it important and

useful to consider how they will enable and motivate the poor to move along ‘development pathways’ that lead to increasing prosperity, food security, equity and sustainability.

### Where are we headed?

As human populations increase, a number of different development pathways could unfold. People might fight over increasingly scarce natural resources and not replace those that are removed, spiraling downward into

ever-greater poverty. Or, they could invest in their lands, increasing their production efficiency, incomes and total output, meeting the needs of ever-larger populations.

Both scenarios have been observed in different situations. The research-for-development community has a major role to play in steering development towards the second type of pathway. Such pathways need to have the following characteristics.

### Enhance the natural resource base

Unreliable rainfall and nutrient-poor soils are hallmarks of the dry tropics. Without addressing these issues, sustained productivity gains are unlikely. For example, the impacts of improved crop varieties have often fallen short of expectations because these aspects were overlooked or assumed to be somebody else's problem. A development pathways perspective compels us to keep them in mind.

### Consider the circumstances

Possibilities will be greatly influenced by enabling elements in the environment such as policy, governance, infrastructure, services, institutions, education, health care and others. A development pathways perspective considers how prospective

steps along the path will be influenced by these elements. For example, if grain prices are kept artificially low by cheap subsidized imports, and fertilizer prices high due to transport and border costs, then high-input cereal cropping may not be a practical step until such constraints can be overcome.

### Increase incomes

Even the most effective interventions will not have impact if they are not used. Profitable technologies strongly motivate uptake by poor farmers, as long as the enabling conditions are in place such as affordability, access, and knowhow. Profits enable farmers to invest in the next step in the development pathway.



*Value-added uses for traditional crops, such as sorghum stalks for bioethanol, build on existing farm skills, increase livelihood options and connect the poor to income-boosting markets.*



## Connect to markets

Markets are the source of the profits that motivate progress along development pathways. Without growing markets, the adoption of more productive practices simply creates produce that cannot be sold at a remunerative price, leaving farmers worse off than before. A development pathway perspective requires that we carefully consider how the increased output of goods and services will be translated into hard cash.

## Manage risks

Drought and marketing uncertainty (prices) are two main risks in the dry tropics. As they increase their investments to respond to market opportunities, farmers may be taking on more risk. A debilitating drought can wipe out years of progress, pushing them back to square one on their development pathway. A range of strategies have been devised to help manage these risks, including diversification, water harvesting, weather forecasting, crop insurance, inventory-credit associations, and others (e.g. see previous 'What ICRISAT Thinks' on drought and on microdosing).

## Diversify

Diversification helps spread risk and increase incomes. A wide range of

crops can be grown in the sunny, moderate climates of the dry tropics, if drought risk can be managed. Many of these are high-value crops with strong market potential. Diversification thinking can go beyond crops and agriculture to include off-farm enterprises that are less vulnerable to drought.

## Innovate

A degree of despondency often accompanies development thinking about the dry tropics. Assumptions that little can be done need to be challenged. Many of the richest agricultural areas in the world are in dry areas (e.g. California, France). Dryland farmers in the developing world continuously innovate to capture new opportunities. A development pathway perspective should for example consider how these areas might progress towards irrigation development, which can fundamentally transform what is possible.

## Customize and adapt

There is no single 'one-size-fits-all' development pathway to be handed out to the inhabitants of the dry tropics. Conditions differ enormously. In some rangeland settings, extensification makes more sense than intensification. If markets cannot be accessed, the pathway needs to focus on food security and self-sufficiency. Within-season, farmers need to adapt to changing weather

patterns and markets. Rather than prescriptive recipes or technologies taken off the shelf, the research-for-development community needs to provide prototypes, principles, and knowledge that local communities can choose from, customize and adapt to local trends and circumstances.

## Steady and sustained

Development pathways thinking can get us away from the 'quick-fix' mentality that is better suited to short-term project organization, than to long-term sustainable development. Development pathways thinking



*"Gum Arabic" sap globules are a fine-quality organic emulsifying agent. Traditionally collected from the wild by the poor, Acacia senegal trees are being domesticated for community plantation culture, a development pathway that can substantially boost incomes if accompanied by quality assurance protocols and strong marketing.*

recognizes that in order to step into the future, one foot has to first be firmly grounded in the present. Farmers are pragmatic; they will first test a new intervention on a small part of their land, gradually expanding only if and when it proves its mettle. This safeguards them against the 'boom-and-bust' calamities that have too often resulted from pressures for quick fixes.

## A development pathway begins with a single step

Confucius famously said that 'a journey of a thousand miles begins with a single step'. Before taking that step, though travelers need to know where they are headed, and what they need to carry to reach their destination. We in the research-for-development community can better assist them in this planning by adopting a development pathways perspective.

We need to plan how one step forward will enable the next step, and how the obstacles ahead will be cleared. We need to consider what is necessary for a safe journey that reaches the desired destination of sustainable prosperity and security.

Research-for-development institutions thus have key roles to play in the march along dryland development pathways. As we walk alongside the poor, we find ourselves inspired by their optimism, ingenuity and adaptability.

# Feedback from High-Profile Donors, Stakeholders and Distinguished Scientists

*(in reverse chronological order)*

Subject: RE: What ICRISAT Thinks about High-Value Crops

*Thanks, Willie, for this very interesting briefer on cash crops for income generation in semi-arid regions. It comes at the right time especially with the renewed donor attention for Sahelian countries like Niger.*

*Harry Bottenberg, Ph. D.  
Agricultural Development Advisor  
USAID, West Africa Regional Program  
Accra, Ghana*

\* \* \* \* \*

Subject: RE: What ICRISAT Thinks about High-Value Crops

*Dear Dr William D. Dar,*

*I thank you a lot for the transmission of this instructive and quite elaborate document dealing with high-value crops. These crops are very important for reduction of poverty.*

*Thanks again for your great collaboration.*

*Sincerely Yours,  
Dr AMADOU Moustapha  
Directeur Général  
Institut du Sahel (INSAH/CILSS)  
BP 1530, Bamako, Mali*

Subject: RE: What ICRISAT Thinks: Defeating Dryland Risk

*Dear Dr. Dar,*

*Thank you very much for sharing the latest edition of What ICRISAT Thinks, on defeating dryland risk.*

*You make a compelling argument on how many small improvements in soil, crop and livestock improvement, input-output policies, and knowledge management can add up to do much to reduce risk for dryland farmers.*

*These messages are particularly important, especially as global awareness of impacts of climate change and the need for adaptation to climate change is rapidly increasing. Additional, environmental benefits that can arise from improved dryland management and defeating dryland risk could also include, for example, improved hydrological regulation, reduced soil erosion and nutrient loading, better water quality, and carbon sequestration.*

*Thank you for sharing What ICRISAT Thinks, which I always read with great interest, and I support the wide dissemination of these messages.*

*With best regards,  
Gemma Shepherd  
Ms. Gemma Shepherd, PhD  
UNEP, Division of Early Warning and  
Assessment  
P.O. Box 30552, Nairobi, Kenya*

*\* \* \* \* \**

**Subject: RE: What ICRISAT Thinks:  
Defeating Dryland Risk**

*Dear Willie,*

*Thank you indeed for this interesting newsletter. It comes at the right moment while Germany is in a broad discussion on climate change. In the near future there will be more funds for research on climate change adaptation and mitigation. Hopefully we can make part of it available for international agricultural research.*

*Best regards  
Michael  
Michael Bosch  
GTZ*

*\* \* \* \* \**

**Subject: RE: What ICRISAT Thinks:  
Defeating Dryland Risk**

*Dear Willie,*

*Many thanks for your (as usual) well presented insights - the number of available/potential stepping stones is larger than most people imagine, and I'm sure you could have mentioned more. The big problem I see is that many of them aren't currently in the right places for the poor to step on them on a fruitful journey - and as you point out they may be too far apart to permit the most needy travellers*

*to leap from one to another - but I am sure that the current interest in climate change affords a great opportunity to engage with those who have the resources and willpower to correctly position (and enable) the stepping stones to be advantageously positioned - but they need more help in doing so, from those who understand where each stone can lead - that's ICRISAT and others.*

*Best wishes*

*Jonathan  
Dr Jonathan Wadsworth  
Senior Rural Livelihoods Adviser  
Central Research Department  
Department for International Development  
1, Palace Street London SW1E 5HE  
United Kingdom*

*\* \* \* \* \**

**Subject: RE: What ICRISAT Thinks:  
Defeating Dryland Risk**

*Dear Willie,*

*Thank you also for sending the April letter of ICRISAT. I truly liked it a lot and plan to use it as a great reference material for my presentations on climate risk management. I truly liked the approach that you mention for tackling climate change by acting today, by fighting today's vulnerabilities. Again, it is an excellent brochure.*

*I was also happy to see the graphs resulting of the past collaboration between ICRISAT and IRI, my institute. I believe there is a great potential and wonderful opportunities to work together in the future in the general area of climate risk management for the semiarid tropics.*

Thanks again Willie. Hope to see you soon.

Walter  
Walter E Baethgen  
IRI, Columbia

\* \* \* \* \*

-Subject: RE: What ICRISAT Thinks:  
Defeating Dryland Risk

Dear Dr. Dar,

Thank you for sending me the ICRISAT newsletter. 'Defeating Dryland Risk' was especially interesting. Dryland producers worldwide face similar risks. The trick is to find an array of crops that can be grown together and in rotation that in aggregate find the environment to be normal, rather than stressful. I particularly like ICRISAT's emphasis on mixed deep-rooted perennials with annuals. Developing a weather prediction system that can provide farmers with information that permits them to maximize return through appropriate selection of seed, fertilizer and pest management technologies is a critical need for us all.

I expect that many more funding opportunities will arise in the near future, and will invite ICRISAT to work with us to make our goal of the development of a strong, sustainable global rural society a reality.

All the best from Bozeman,  
Prof. Tom Blake  
Department of Plant Sciences and Plant Pathology, Montana State University  
USA

Subject: RE: What ICRISAT Thinks:  
Defeating Dryland Risk

Dear Dr. Dar,

Thank you very much for your newsletter. Very useful indeed. We are continuously challenged in the Bank to show how the US\$50 million that we put annually into the CGIAR supports the Bank's development initiatives globally. The work highlighted in your newsletter helps us strengthen our case.

Thanks very much and looking forward to hearing more about the very nice work that you and your teams are doing.

Best wishes,

Erick  
Erick Fernandes, PhD  
Land Management Adviser  
The World Bank, SDN-ARD  
[MC5-515]  
1818 H Street, Washington, DC 20433,  
USA

\* \* \* \* \*

Subject: RE: What ICRISAT Thinks about  
Climate Change

Dear Mr. Dar,

Many thanks for sending the ICRISAT Newsletter.

IIED has a strong interest in climate change impacts particularly on the world's poor and we also have a strong interest in Drylands. We would be happy to distribute your newsletter to our many partners in Africa and Asia.

We would also be happy to explore possible collaboration between ICRISAT and IIED on this issue in future. I am attaching some information on the work we are doing with partners in the least developed countries (LDCs).

With best regards  
Saleem  
Dr. Saleemul Huq  
Director  
Climate Change Programme  
International Institute for Environment and Development  
3 Endsleigh Street  
London WC1H 0DD  
United Kingdom

\* \* \* \* \*

Subject: RE: What ICRISAT Thinks --  
Biofuel Crops: Power to the Poor

Dear Dr. Dar:

Thank you very much for your very interesting Newsletter. I hope you will put me on your regular list of those receiving "What ICRISAT thinks". Please include Dinesh Joshi at Barwale Foundation if you have not already done so.

You probably know that Dr. Barwale is especially interested in *Jatropha* which you discuss as a biodiesel fuel.

I think its great that ICRISAT is thinking along these lines to help the poor in ICRISAT's area of the world. As you recognize there will be lots of "twists and turns" in the road but they could get much worse if the challenge is not recognized right away.

Best personal regards  
Sincerely  
Wayne  
Wayne Freeman

\* \* \* \* \*

Subject: Excellent Media Product

Dear Directors, Colleagues

I would like to share what I think is an excellent media product; Excellent because it is timely, relevant and topical because the issue of biofuels has been in the news, and energy is a BIG issue. This product is also highly attractive because it comes from "experts" – scientists/researchers, and is addressing poverty another global **BIG** issue. It is the kind of product that **STOPS PRESS.**

And it did it for me. I stopped all I was doing and sent it to the media resulting in two interview requests from a Kenyan radio station and VOA in the US. Journalists/editors of *Zambian*, *Uganda* and *Kenyan dailies* have acknowledged and thanked me for sharing this product.

Indeed, it is such a good product I am thinking we should start a series on "What the CGIAR Thinks..." And we could start by addressing the issue of Bill Gates – Ford Foundations partnering to support agricultural research. The *New Scientist* would very much like to know what we think.

I will happily collate your thoughts and get us coverage at the very least in the *New Scientist*. The Gates-Ford Foundation pieces follows below after "What ICRISAT

Thinks ..."  
Regards  
Catherine  
Catherine Mgendi

\* \* \* \* \*

Subject: FW: What ICRISAT Thinks --  
Biofuel Crops: Power to the Poor

Dear Willie,

Thank you for the update on ICRISAT-activities to develop biofuel feedstock. I think you are correct in saying that the biofuel issue you have been working on for years has now moved to center stage. Here at SDC/NRM, the issue is also rapidly gaining in relevance. Several of our country offices, India among them, have begun to explore the issue.

There are many facets to this topic, my team and myself look forward to staying in contact with you for mutual exchange of experiences and ideas on biofuels.

Meanwhile best regards,  
Martin  
Martin Sommer  
Swiss Agency for Development and Co-operation SDC  
Head NRE - Natural Resources & Environment Division  
Freiburgstrasse 130  
CH - 3003 BERN

\* \* \* \* \*

Subject: RE: Microdosing in West Africa

Hi Willy

Thanks for this. Please add me to your mailing list.

Kind regards  
Roy  
Roy Steiner PhD  
Senior Program Officer  
Agricultural Development  
Bill & Melinda Gates Foundation  
P: 206 709 3362 C. 206 310 4976  
roy.steiner@gatesfoundation.org

\* \* \* \* \*

Dear Willie,

Thank you very much for your paper on Don't Desert Drylands. It has been prepared very well. I am requesting Dr K Bhanumathi, Head of the Hindu Media Resource Centre to bring it to the attention of all concerned.

On November 19-20 the National Academy of Agricultural Sciences will be organizing in New Delhi a National Consultation on Deserts and Desertification with particular reference to the hot desert of Rajasthan and cold desert of Lahaul - Spiti and Ladak. We are inviting the President of Afghanistan to inaugurate the Consultation. He is expected to be in New Delhi on November 19th to receive the Indira Gandhi Prize for Peace, Disarmament and Development.

I shall be very grateful if you could kindly deliver the keynote address on November 19th. In case it is possible, I shall be grateful if ICRISAT can co-sponsor this meeting with NAAS.

With warm personal regards,  
Yours sincerely,  
M S Swaminathan  
PROF M S SWAMINATHAN  
Chairman, National Commission on

*Farmers, Govt. of India; President, Pugwash Conferences on Science and World Affairs; Chairman, M S Swaminathan Research Foundation, Third Cross Street, Taramani Institutional Area, Chennai - 600 113 (India).*

\* \* \* \* \*

**Subject: RE: What ICRISAT Thinks: Don't Desert the Drylands!**

*Dear Dr. Dar:*

*Thank you for the newsletter that we find interesting as usual. I have circulated to others in the Bank for any comments, particularly in relation to the areas of possible collaboration.*  
*Kats Matsunami*

*Kats Matsunami , ADB*

\* \* \* \* \*

**Subject: Re: What ICRISAT Thinks - about crop diversification in the drylands**

*Dear Willie,*

*Thanks for sharing with me the regular newsletters you are now distributing. I like the idea and this latest one is good in that it recognizes the role of non-technical aspects in upscaling the initiatives you are developing. My impression is that we have a lot of very good techniques and packages available but we have problems in finding out how to get them upscaled. Surely, that is one of the issues we have emphasized in the TerrAfrica initiative where we talk much more about upscaling as you know. But we need to expand that discussion to include many more actors on the development scene and we need to find out how to do that.*

*I look forward to meeting you and your colleagues next time around and thanks again for sending the material.*

*Regards,  
Per  
World Bank*

\* \* \* \* \*

**Subject: RE: What ICRISAT Thinks - about crop diversification in the drylands**

*Dear Willie,*

*Yet again your 3rd short letter has hit the mark. It is great to see that you and your team are putting out a positive message rather than the more often seen and heard negativism.*

*I hope that your positive messages are being well received by your stakeholders – and maybe also being reflected in improved financial support for ICRISAT.*

*Regards,  
BillW  
Bill Winter  
ACIAR, Australia*

\* \* \* \* \*

**Subject: RE: What ICRISAT Thinks - about crop diversification in the drylands**

*Willie:*

*Excellent description. Thanks for sending the letter describing the excellent progress being made with ICRISAT's help.*

*Roger*

*[Note: Roger Beachy is a distinguished scientist, an ICRISAT Governing Board*



*member, President of Danforth Research Institute, and high ranking member of the National Academy of Sciences, USA.]*

\* \* \* \* \*

**Subject: RE: What ICRISAT Thinks**

*Dear Willie:*

*Thank you very much for your innovative and informative newsletter. I am very pleased that good progress is being made on micro-dosaging in Niger. In arid and semi-arid areas, where risks are high, very small amounts of fertilizers can make a big difference - especially when combined with proper water management/harvesting methods. As you know, The Rockefeller Foundation also supported ICRISAT's work on micro-dosaging in Zimbabwe.*

*Please send me additional information on your "warrantage systems" and any economic analysis/impact assessment done on this and the micro-dosaging work.*

*Africa needs to end the current fertilizer crisis if it is to have any change of a green revolution. What we have now is a "brown revolution" where the continent loses \$ 4 billion of soil nutrients annually.*

*The time for action has come. Thanks, again, for a very interesting report. I look forward to reading your future issues of the newsletter.*

*Best wishes*

*Akin*

*Akin Adesina*

*Associate Director, Food Security*

*The Rockefeller Foundation*

**Subject: RE: Microdosing**

*Dear Dr. Dar:*

*I am interested in your project "Micro-dosing of fertilizer" for African dry land agriculture, especially for maize and sorghum.*

*What progress was made in 2005 toward bringing this idea to commercial application in one or two pilot project areas? Have you discussed this approach with Dr. Amit Roy, Director General of International Fertilizer Development Center? Have you explored the possibility of forming "Micro-credit Groups" such as was developed by Dr. Muhammad Yunus in Bangladesh, for successfully financing very small projects in crafts and micro-business projects?.*

*If you have not looked into such an approach to financing your "micro-dosing" fertilizer plans, I suggest you contact both Drs. Amit Roy (IFDC) and Muhammad Yunus ((Grameen Bank, Bangladesh). The Grameen Bank Micro-Credit System has been used to successfully start many different types of very small businesses in different countries in the last decade.*

*Sincerely,*

*Norman E. Borlaug*

*[Note: Dr. Norman E. Borlaug, one of history's greatest humanitarians, is father of the Green Revolution and one of the most distinguished agricultural scientists of all time. He recently received the USA's highest civilian honor, the Congressional Gold Medal. He is one of only five people in all of history to be awarded the Nobel Peace Prize, the Presidential Medal*

*of Freedom and the Congressional Gold Medal. The other four are Nelson Mandela, Elie Wiesel, Mother Teresa and Dr. Martin Luther King, Jr. It is said that Norman Borlaug saved more human lives than any other person in history.]*

*\* \* \* \* \**

**Subject: RE: What ICRISAT Thinks**

*Dear Willie*

*Spot on! How often is crop production in dry areas limited more by low fertility than by lack of moisture: Sahel, Zimbabwe, Limpopo Province, Australian Mallee, and*

*earlier on, barley lands of WANA. I don't know whether northern donors still think chemical fertilizer is "bad", I suspect there is still an element of this in their thinking. I like to ask them what they have done about recycling the nutrients that they themselves consume!!*

*Best regards*

*Tony Fischer*

*[Note: Dr. Tony Fischer is a distinguished plant physiologist who has held a number of leadership and governance roles across the CGIAR over the past three decades.]*



## About ICRISAT®



The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

### Contact Information

#### ICRISAT-Patancheru (Headquarters)

Patancheru 502 324  
Andhra Pradesh, India  
Tel +91 40 30713071  
Fax +91 40 30713074  
icrisat@cgiar.org

#### ICRISAT-Bamako

BP 320  
Bamako, Mali  
Tel +223 2223375  
Fax +223 2228683  
icrisat-w-mali@cgiar.org

#### Liaison Office

CG Centers Block  
NASC Complex  
Dev Prakash Shastri Marg  
New Delhi 110 012, India  
Tel +91 11 32472306 to 08  
Fax +91 11 25841294

#### ICRISAT-Bulawayo

Matopos Research Station  
PO Box 776,  
Bulawayo, Zimbabwe  
Tel +263 83 8311 to 15  
Fax +263 83 8253/8307  
icrisatzw@cgiar.org

#### ICRISAT-Nairobi (Regional hub ESA)

PO Box 39063, Nairobi, Kenya  
Tel +254 20 7224550  
Fax +254 20 7224001  
icrisat-nairobi@cgiar.org

#### ICRISAT-Lilongwe

Chitedze Agricultural Research  
Station  
PO Box 1096  
Lilongwe, Malawi  
Tel +265 1 707297/071/067/057  
Fax +265 1 707298  
icrisat-malawi@cgiar.org

#### ICRISAT-Niamey (Regional hub WCA)

BP 12404  
Niamey, Niger (Via Paris)  
Tel +227 20722529, 20722725  
Fax +227 20734329  
icrisatnc@cgiar.org

#### ICRISAT-Maputo

c/o IIAM, Av. das FPLM No 2698  
Caixa Postal 1906  
Maputo, Mozambique  
Tel +258 21 461657  
Fax +258 21 461581  
icrisatmoz@panintra.com

Visit us at [www.icrisat.org](http://www.icrisat.org)