Project TCP/EGY/3102
‘Rice Straw Management and Conservation of Environment’

Technical Manual
‘Agro-Industrial Use of Rice Straw’

Food and Agriculture Organization of the United Nations
Regional Office for the Near East,
Cairo, Egypt

Ministry of Agriculture and Land Reclamation,
Cairo, Egypt

April 2009
Cover Photograph

*Industrial compost making: turning/mixing machine working along a compost windrow.*

Credit: Peter Steele, May 2008
Technical Manual
‘Agro-Industrial Use of Rice Straw’
Exploring opportunities for making better use of rice residues in Egypt

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* Photographs credit: Peter Steele, Divine Njie & FAO

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<tr>
<td>ADF</td>
<td>African Development Fund (of the AfDB)</td>
</tr>
<tr>
<td>AERI</td>
<td>Agricultural Engineering Research Institute (of the ARC)</td>
</tr>
<tr>
<td>AIDB</td>
<td>African Development Bank</td>
</tr>
<tr>
<td>AF</td>
<td>Arab Fund</td>
</tr>
<tr>
<td>AGFUND</td>
<td>Arab Gulf Program for the UN Development Fund</td>
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<tr>
<td>APR</td>
<td>Agricultural Policy Reform (of the GoE)</td>
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<tr>
<td>ARC</td>
<td>Agricultural Research Center (of the MALR)</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>AU</td>
<td>African Union</td>
</tr>
<tr>
<td>B</td>
<td>Billion ( (1,000,000,000 \text{ or } 10^9) )</td>
</tr>
<tr>
<td>B2B</td>
<td>Business-2-Business Program (of DANIDA &amp; GoE)</td>
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<tr>
<td>BDF</td>
<td>Biodiesel fuel</td>
</tr>
<tr>
<td>BDSSP</td>
<td>Business Development Services Center Support Project (Alexandria Univ.)</td>
</tr>
<tr>
<td>CAES</td>
<td>Central Administration Extension Services (of the MALR)</td>
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<tr>
<td>CDM</td>
<td>Clean Development Mechanism</td>
</tr>
<tr>
<td>CI</td>
<td>Cooperazione Italiana</td>
</tr>
<tr>
<td>CIDA</td>
<td>Canadian International Development Agency</td>
</tr>
<tr>
<td>COMESA</td>
<td>Common Market for East &amp; Southern Africa</td>
</tr>
<tr>
<td>C:N</td>
<td>Carbon/nitrogen ratio (used for soil analysis)</td>
</tr>
<tr>
<td>CRC</td>
<td>California Rice Commission</td>
</tr>
<tr>
<td>CTA</td>
<td>Chief technical advisor</td>
</tr>
<tr>
<td>DANIDA</td>
<td>Danish International Development Assistance</td>
</tr>
<tr>
<td>DBP</td>
<td>Development business profile (supported by DANIDA)</td>
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<tr>
<td>EAS&amp;TS</td>
<td>Egyptian Association for Science &amp; Technologies Services</td>
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<tr>
<td>ECO</td>
<td>Environment Compliance Office (supported by DANIDA)</td>
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<tr>
<td>EEAA</td>
<td>Egyptian Environmental Affairs Agency (of the Ministry of Environment)</td>
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<tr>
<td>EIB</td>
<td>European Investment Bank</td>
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<tr>
<td>ENCP</td>
<td>Egypt National Cleaner Production Center</td>
</tr>
<tr>
<td>EPF</td>
<td>Environmental Protection Fund (supported by DANIDA)</td>
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<tr>
<td>EPSF</td>
<td>Environment, Peace and Stability Fund (of the Danish Government)</td>
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<td>ESP</td>
<td>Environment Sector Program (supported by DANIDA)</td>
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<td>ETRACE</td>
<td>Egyptian Traceability Center for Agro-Industrial Exports</td>
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<tr>
<td>EU</td>
<td>European Union</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization (of the United Nations)</td>
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<td>FCRI</td>
<td>Field Crops Research Institute (of the ARC)</td>
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<tr>
<td>FTRI</td>
<td>Food Technologies Research Institute (of the ARC)</td>
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<tr>
<td>GCC</td>
<td>Gulf Cooperative Council</td>
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<tr>
<td>GDP</td>
<td>Gross domestic product</td>
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<tr>
<td>GEF</td>
<td>Global Environmental Fund</td>
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<tr>
<td>GoE</td>
<td>Government of Egypt</td>
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<td>HI</td>
<td>Harvest index</td>
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<tr>
<td>IDB</td>
<td>Islamic Development Bank</td>
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<tr>
<td>IPU</td>
<td>Investment Promotion Unit</td>
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<tr>
<td>JBIC</td>
<td>Japan Bank for International Cooperation</td>
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<td>JICA</td>
<td>Japanese International Cooperation Agency</td>
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</table>
LPG  Liquid petroleum gas  
MALR  Ministry of Agriculture and Land Reclamation  
MC  Moisture content  
MDG  Millennium development goals  
MSW  Municipal solid waste  
N  Nitrogen  
NBEC  National BioEnergy Center  
NEPAD  New Partnership for Africa’s Development  
NGO  Non-governmental organization  
NPD  National programme coordinator  
NTF  Nigerian Trust Fund (of the AfDB)  
ODA  Official development assistance (of JICA)  
OM  Organic materials (for compost making)  
PFL  Post-Harvest Loss Program (of FAO)  
PMC  Project management committee  
PPP  Public-private partnership  
PTO  Power take-off (i.e. mechanical tractor drive shaft for external equipment)  
R&D  Research and development  
RMC  Rice Mechanization Center (of the AERI of the ARC)  
RR&TC  Rice Research & Training Center (of the ARC)  
RSA  Rice straw ash  
SFD  Social Fund for Development  
SME  Small and medium enterprises  
SWERI  Soils, Water & Environmental Research Institute (of the ARC)  
TA  Technical assistance  
TCRAR  Training Center for Recycling Agricultural Residues (of SWERI)  
TDN  Total digestible nitrogen  
UA  Units of account (funding management procedure of AfDB)  
UNDP  United Nations Development Program  
UNEPI  United Nations Environment Program  
UNIDO  United Nations Industrial Development Organization  

**Units**

- B  billion  
- Cal  calorie  
- fed  feddan (4,200 m$^2$ or 0.42 ha)  
- g  gram  
- GJ  Gigajoules ($J \times 10^9$)  
- h  hour  
- ha  hectare (2.4 fed or 10,000 m$^2$)  
- kCal  kilocalories  
- kJ  kilojoules ($J \times 10^3$)  
- km/km$^2$  kilometre/kilometre squared  

x
Technical Manual: Agro-Industrial Use of Rice Straw
Project TCP/EGY/3102

kW/kWh kilowatt/kilowatt hour
M million \((1,000,000 \text{ or } 10^6)\)
m/m³ metre/cubic metre
mg milligram
mm millimetre
MJ Megajoules \((J \times 10^6)\)
 yr year
 t tonne

**Currencies and Currency Conversions**

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<th>LE</th>
<th>Egyptian Pound</th>
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<tr>
<td>US$</td>
<td>United States Dollar</td>
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<tr>
<td>€</td>
<td>Euro</td>
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US$ 1.00 = LE 5.60
LE 1.00 = US$ 0.18
€ 1.00 = LE 8.50
LE 1.00 = € 0.12

Note: Currency conversions valid as at 31 December 2008
Executive Summary

Issues of straw disposal

Rice straw is produced throughout the world as a by-product of rice cultivation. More than two billion people eat rice as a staple food, and the crop dominates cereal production in many low-income countries. The options for disposal of straw are limited and include burning, composting and feeding on-farm. Off-farm, the straw is used for a host of processing activities – livestock feed, compost, pulp, extracts and/or fibers. Straw is also burned in the home, and sometimes for commercial heat or power. In-field burning in Egypt has been illegal by law for more than 15 years, but these laws are widely flouted and this results in widespread aerial pollution over neighboring urban areas. Economic, technical and, importantly, political efforts have been made to address these issues with opportunities identified for adding value, creating employment and boosting the socio-economic security of local people.

Technical manual ‘straw utilization’

A technical manual ‘Agro-Industrial Use of Rice Straw’ represents a summary and analysis of information collected by the TCP/EGY/3102 Project team during the period 2007-2008. The manual explores some of the many issues involved and has been designed to help promote on-going initiatives – identifying ‘who is doing what, where and in partnership with whom’. The manual is not a ‘do-it-yourself’ guide, for example, to mushroom growing or feeding livestock, for this information is already widely available from reliable sources. People, institutes, companies, agencies and others involved in the many sectors are identified for the potential offered.

Importance of agriculture in Egypt

More than half the population of Egypt is dependent upon a viable agricultural economy, but the country has limited natural resources and remains with a traditional approach to rural investment (i.e. small scale traditional technologies, insufficient information, inadequate credit, limited shared effort and similar). Continuity of approach will not suffice into the immediate future. Improved coordination is required within the public sector with more opportunities for public/private partnerships. This will enable rural communities and agro-industrial investors to better understand the complexity of the many issues that apply. It will encourage the development of a service sector. There is a need for a shift from ad hoc investment and piecemeal industrialization that the country gains greater synergy and more value from current investments based on agriculture.

Straw harvesting

Cost-efficient logistics of straw harvesting and shipment to factories remains the basis of profitability for all straw-based enterprise development. Reliable delivery of baled straw of known quality will be essential for high-
investment products such as electricity. Straw is collected loose for use on the home farm and in the local community (for traditional products). More than 1,000 conventional balers have been delivered to rural communities, Ministry of Agriculture and Land Reclamation, Ministry of Defence and others by the Ministry of Environment during the past 10 years, and more than 500,000 t of straw was baled during 2008. Straw deliveries to the RAKTA papermaking factory at Alexandria represent the only long-term domestic experience available. Increased commercial demand for straw will drive up prices and this will result in the establishment of more rural services and increased competition. For the current period farmers are largely price-takers. No reliable cost-benefit/evaluation of harvesting, storage and delivery of straw is available.

**Recycled organic materials**

Compost is the main traditional outlet for small-scale rice producers with estimated 20 percent or less of all home-grown straw being made into compost for local use. With the reduction of state subsidies for manufactured fertilizers, small-scale production is likely to increase. Rice straw compost is also produced on commercial scale and a number of large-scale factories have been constructed. Issues of markets and pricing arise, and returns on investment may be low. Price rises are likely to result in higher sales of straw off-farm, which could deprive small-scale farmers of access to low-cost nutrients and livestock feed. Fresh straw can be used as mulch (which then decomposes into the soil) and decomposed straw is an excellent substrate for mushroom production, although this is a food that is not widely eaten in Egypt.

**Livestock feed**

Rice straw is a valuable ingredient of feed during the second half of the year for many small-scale livestock owners when rotational clover is no longer available. Egypt has a national herd of 17-18 million ruminants. Of the order 25 percent of all rice straw is fed to livestock and of this estimated 25 percent is chemically treated with urea and/or ammonia to boost nutritional value and palatability. The extent of commercially manufactured livestock feed remains unknown. The small-scale livestock producer is likely to face issues of cost/supply into the next period as competition for straw from other users arises. Some measures of security may be required to protect the sector.

**Novel uses for straw**

Paper, cardboard and similar materials can be successfully manufactured from cereal straw. The RAKTA Company of Alexandria is a public sector venture with more than 40 years industrial experience of paper manufacture. The company is one of two companies producing paper from natural fibers/pulp in the country. Environmental issues have risen to prominence in recent times and, in 2008, this resulted in closure of the straw/paper manufacturing line.

There are elements of impracticality with many novel opportunities for which straw can be used. Many remain in the realm of R&D and
experimentation, with little reality for the real costs involved. Egypt has demonstrated technical capability for a range of extracts, chemicals, fertilizers, charcoal and similar products, services and markets, but commercial opportunities remain under-explored. Small-scale manufacture of marketable products with low investment demand and few risks should be supported in rural communities.

Residues from rice are widely exploited for heat in rice-producing countries worldwide and many hundreds of thousands of people continue to cook on specially designed rice husk stoves. Others use gasification and biogas systems on household scale, and others explore community-scale electricity generation from locally produced biomass. Findings from the FAO/GoE TCP project showed no systematic use of rice residues for energy content in households in the Nile Delta, although R&D and pilot-scale ventures have attracted attention and some agency-led investments have been made. National subsidies for selected petrochemical fuels have encouraged people to shift to electricity and LPG for home and commercial use. The small quantities of biomaterials available nationally make large-scale bio-energy investment less likely into the next period.

**Working in partnership**

Egypt has many successful development programs underway in partnership with the main international agencies and key donor countries. Without exception, these focus upon socio-economic development of people and communities linked to the technological issues, for example of providing development funds, expertise, information, infrastructure, capacity building, training and similar and, crucially for a rapidly urbanizing country living on the fringe of a desert, for environmental understanding, sensitivity and sustainability. Investment in natural resources has remained a priority and, more recently, this has linked exploitation to employment and income generation and, ultimately, to improved living standards, community well-being and social stability. For a nation with a rapidly expanding population, the challenge is one of keeping pace with the demands of economic security. During the next 10 years, this will lead to greater priority for investment in agriculture, agro-industries, social infrastructure and rural-urban services that will add value throughout the production-processing-trading chain.

The FAO/GoE TCP project was able to share in the networks of information available; to enable small resources available for agro-residues investment to be better used. The outcome has been a portfolio of summaries of agency-led work/investment that will boost the efficiency of decision making for agro-residues utilization during the next 5-10 years. Many shared opportunities exist. A concept note has been prepared proposing investment of more than US$6M. UNDP/GEF has a rural energy-related program beginning 2009 with investment of more than US$16M. The Environmental Investment Fund has US$63M available for minimum of five years. JICA and the Ministry of Agriculture and Land Reclamation/ARC have a shared proposal for US$2M ‘Development Study’ in consideration. The African Development Bank will begin an agro-industrial investment program during 2009 to help boost national food security.
Investing in the future

The public sector has enjoyed a strong tradition for national planning during more than 50 years. This is reflected in the domination of the economy by state-run companies and state-funded initiatives but, importantly, this approach is now changing. Key ministries – Trade & Industry, Investment, Economic Development and Environment are making efforts to attract domestic and international investors into private sector and/or public/private sector ventures. Many opportunities offered are agro-industries based - including agro-residues utilization. Greater cooperation is required between the ministries and agencies involved if rural communities are to gain benefit during the next 10 years.
Acknowledgements

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Preface

The materials assembled within the program of activities of the FAO/GoE project TCP/EGY/3102 ‘Rice Straw Management and Conservation of Environment’, and described and analyzed in this manual will bring greater understanding of the complex nature of the many issues involved. This will help determine potential for agro-industrial development within the communities that make a living from agriculture. The project has been one of many similar investments made during more than 15 years; and since widespread burning of surplus straw first began to impact upon the cities of the Nile Delta. The success on the one part – with the development of rice production technologies and practices – simply shifts the challenge to other parts of the agricultural spectrum; with the investment required for handling the large quantities of residues produced. Investigations of this kind have been underway in Egypt within a host of different programs and investments and by many national institutions. Some of this work has been described in the manual. Other work has remained largely outside the public domain and has generally not been shared within the networks of people involved.

With a national population that is increasing of the order 2 percent annually and living and working largely on the basis of a fixed portfolio of natural resources, government faces a period of challenge into the foreseeable future of maintaining economic growth and providing for rising socio-economic expectations. Here it is that agriculture, which provides about 20 percent of GDP and represents the main source of food and employment across the country, of necessity, must continue to boost productivity to meet present and future needs. Services, manufacturing and industrialization already dominate the economy, but it is the estimated 50 percent of the people living on the basis of agricultural production who face the inequities of diverging national incomes.

The challenges of maintaining equitable growth have not been lost on national managers, and this is reflected in the bias towards manufacturing that continues to rely upon the exploitation of natural resources – in chemicals, textiles and foods. These trends have been noted in the manual and will, ultimately, provide for clear skies over cities in the Nile Delta. Small-scale, pilot-scale, exploratory and R&D activities are well underway to add value to rice straw and to manufacture the feed, food, organic materials and energy products that will create employment and wealth. The private sector is taking an increasing role within shared private-public partnerships with the approach, vision, novelty for doing things in different ways and, importantly, the use of innovative technologies that may be
required. International markets are driving change for a host of different products. This offers models for re-developing and re-investing in higher value production throughout domestic agriculture. Some of these opportunities have been described in the manual.

A focus upon straw utilization in isolation is not practical without some understanding of the national environmental challenges involved – and not simply those of polluted skies and human health that arise when straw is burned in uncontrolled and illegal manner. Egypt will be susceptible to the vagaries of climate change that have been forecast for the next 50 years. Right now the country faces scarcity of fresh water and fertile soils. Production costs are rising in line with global economic trends; for purchasing fuels, fertilizer, transport equipment and other essentials. Production subsidies have become untenable and are being reduced. Materials such as rice straw, previously considered waste, are finding markets; and this may reflect in higher income to growers, but loss of low-cost livestock feed and/or organic materials. Choices will need to be made by growers and by government and its advisors of how best to manage the large quantities of organic materials for the longer-term benefit of people and land. For a desert country both are important.

The managers of the FAO/GoE project and the authors of the manual are to be complimented on the extent, timeliness and practicalities of their investment and on the modest achievements made. They represent one small part of national efforts to provide for resilient national development into the next 10 years but one, moreover, that has considerable potential to catalyze and encourage others. This will be essential.

*Abdessalam OuldAhmed*

*FAO Representative to Egypt*
Chapter 1
Introduction
Country and Opportunities

Summary

Modern rice production in Egypt represents a success story with few equals. Public sector investment in new crop varieties, improved production technologies and utilization efficiency of water resources have produced annual yields of 10 t ha$^{-1}$ and enabled output to keep pace with demand from a rapidly expanding population estimated at 80 million. For a country with few natural resources and living on less than 6 percent of the national territory, it is an unparalleled achievement. Notwithstanding this, efforts must be made to continue to boost yields that they will match the best of the R&D trials – 30 percent higher.

The technical manual represents a summary and interpretation of information collected during the tenure of the FAO/Government of Egypt project during the period 2007-2008 in support of improved use of residues that remain from the domestic production of rice. More than one million tonnes (Mt) residues have always found traditional use on-farm, for example, as livestock feed and nutrient recycling as compost. The introduction of higher-yielding varieties during the past 20 years as a means of raising food production has, however, resulted in surpluses for which little demand exists. Unwanted residues have been burned in situ with resultant aerial pollution over neighboring urban areas. Economic, technical and, importantly, political efforts have been made to address these issues with opportunities identified for adding value, creating employment and boosting the socio-economic security of local people. The manual explores some of the many issues involved and, more importantly, will help promote on-going agro-industrial initiatives – identifying ‘who is doing what, where and in partnership with whom’.

1.1 Egypt today

The value of the present technical manual should be considered in the context of the socio-economic development of Egypt, domestic agricultural production and agro-industrial potential. For this, it is essential to gain some understanding of the country and its resources; and of the many agro-development priority issues that currently apply or are likely arise during the next 5-10 years.
Strictly limited by geography and climate, Egypt has a rapidly growing population living on less than 10 percent of the land area and heavily dependent upon the water resources of the longest river in the world, the River Nile. The country has a land area of 1 million square kilometres. Since the completion of the High Dam at Aswan (now more than 35-years ago), the agro-ecology of the country that dominated the ancient Egyptian empires for more than four millennia has changed for all time. Modern Egypt has traded economic stability, modern infrastructure and power generation for the natural nutrient-base of eroded soils that have been washed down from the African hinterland each year, and which once provided the basis of its agricultural wealth. The long-term ramification of these changes remains to be seen.

What is certain, however, is continued socio-economic dependency of modern Egypt and its estimated 80 million people on the resources of the River Nile. Small populations live in coastal areas, in oases and reclaimed desert lands, and in the Sinai Peninsula, but more than 50 percent of the people live in the handful of main towns and cities. With annual population growth of more than 2 percent, Egypt struggles to maintain some kind of equilibrium within a severely restricted geo-resource base. In recent times, this has reflected in widespread economic reform and high investment in infrastructure and communications. Furthermore, there are regional implications for the country for Cairo, traditionally, has provided the intellectual and political leadership for the Arab States.

Agriculture remains an important source of economic wealth for the country with tourism and services, oil and gas, manufacturing and industries and remittances providing the basis for an annual GDP growth of more than 7 percent in recent times. More than 30 percent of people remain dependent on farming for their living, while 17 percent depend on industry and more than 50 percent on services. Development has been skewed, however, and despite reasonable economic performance the broader population struggles to maintain basic living standards. Estimated 20 percent of the population remains below the poverty line with an additional 13 percent just above it. High levels of subsidy apply for many basic commodities. Current challenges include accelerating inflation (more than 23 percent in mid-2008), high fiscal deficit and rising unemployment.¹

1.2 Value of agricultural investment

There is merit in considering the value of a technical manual focused upon agro-residues potential for the importance of the agricultural sector to national economic security. The contextual issues for adding value to materials currently wasted remain important for employment and wealth creation. Agriculture dominates the socio-economic framework of the country – supporting more than 50 percent of the population (in production and services) and, in a good year, contributing up to 20 percent of GDP. Agricultural industries provide a firm measure of social resilience whereby people in the towns continue to remain linked into networks of traditional rural communities. Harmony of this kind is likely to change during the next 30 years, however, as urban populations expand further and generations develop with little or no access to a rural heritage. This calls for prioritization by national planners to ensure that the economy can continue to provide employment for the estimated 600,000 people entering the workforce each year – and the inherent risks of failing to do so. Agricultural production and agro-manufacturing industries will continue to play a key role into the foreseeable future.

Recent successes with agricultural productivity have come largely from the expansion and improved efficiency of irrigation programs, from providing better market incentives to farmers and from the use of enhanced production technologies. These have boosted yields in traditional growing areas of the Nile Delta and the Nile Valley and, importantly, in the widely promoted agro-industrial areas of the northern Sinai desert, the Cairo-Suez and Cairo-Alexandria corridors and along the Mediterranean coast. Traditional farm practices remain a constraint to productivity in the long-term, however, as exemplified by small-scale, labor-intensive and out-dated technologies, fragmented and overcrowded land holdings, limited infrastructure and inefficient rural services. Higher productivity and increased investment during the next 10 years is likely to lead to fewer (but larger) farms with corresponding smaller rural populations. This will further exacerbate the rural-urban divide and encourage more out-migration (Oxford Business Group, 2007).

Despite the ever higher productivity from limited land resources, the country remains an importer of foods – mainly meats and grains. Egypt is the world’s largest importer of wheat. Hikes in the price of selected international staples (particularly wheat and faba beans) during early 2008 resulted in food riots in urban areas as higher prices were passed on to the consumer, and the government was quick to establish national bakeries
selling bread at subsidized prices (BBC, 2008 & Associated Press, 2008).\textsuperscript{2} The fragility of current food production regimes in the long term has not been lost on government planners and international advisors, and effort is currently being made to boost investment in food and industrial crops development.\textsuperscript{3}

### 1.3 Rice production

Egypt is a highly successful producer of rice with average yield of more than 9.5 t ha\textsuperscript{-1} in 2005/06. The country is unique in the Near East - demonstrating that the gap between actual and achievable yields can be bridged.\textsuperscript{4} National strategic priorities remain those of boosting productivity of the estimated 600,000 - 650,000 ha land on which rice is grown each year, of which 98 percent is located in the Nile Delta. Success with breeding high-yielding-short-straw varieties has enabled the country to boost yields of rice by more than 60 percent since 1980 and, moreover, this has been achieved with 25-30 percent less water consumption mainly by reducing the period required for the plant to reach maturity – by up to 40 days. Therein is the basis of improved land productivity. This is a trend that is likely to continue into the next 20-years (if at diminishing returns as incremental yield increases become increasingly more challenging). Productivity of rice across the six main rice producing governorates of the Nile Delta (and Fayoum Governorate) is described in Table 1 and illustrated in Fig. 1.

### Table 1. Rice area, productivity, and production in Egypt

<table>
<thead>
<tr>
<th>Governorate</th>
<th>Shared Production (%)</th>
<th>Area (ha)</th>
<th>Productivity (t ha\textsuperscript{-1})</th>
<th>Yield (t × 1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gharbia</td>
<td>11</td>
<td>69,720</td>
<td>10.04</td>
<td>700</td>
</tr>
<tr>
<td>Damietta</td>
<td>4</td>
<td>12,530</td>
<td>8.78</td>
<td>110</td>
</tr>
<tr>
<td>Kafr El-Sheikh</td>
<td>19</td>
<td>103,870</td>
<td>10.59</td>
<td>1,100</td>
</tr>
</tbody>
</table>

\textsuperscript{2} Subsidized food. Issues of food security will continue to dominate public planning into the next period. For example, Egypt spends of the order US$850M on subsidizing bread each year. More effective use of agro-residues will reflect in the creation of more jobs and income for people.

\textsuperscript{3} Agro-industrial investment. Exemplifying one leading investor; the African Development Bank plans an initiative during 2009/2010 to boost agro-industries (and particularly food industries) development in Egypt. Further information to describe AfDB investment planning is contained in Annex 1.

\textsuperscript{4} Yield of grain. Yields vary with reporting and date of publication, but have generally been rising during the past 25 years. According to Badawi (2004) Egypt is producing rice at near maximum potential, and provides an example that can be followed by regional countries.
Behind yield indicators there is productivity based upon tolerance to salinity and/or drought, to the suitability of varieties selected for intensive cultivation, to tolerance or resistance to plant pests and/or diseases and, importantly, to the high quality of the grain produced – that it exhibits the milling and baking characteristics that are required by local people. Technical development never remains static, however, and R&D and extension programs remain in place to boost uptake of hybrid varieties to make further use of biotechnologies, to mechanize production and to continue to raise productivity.5

Fig. 1. Rice Crop

One of the first rice crops to be sown in Egypt using ‘conservation agriculture’ practices. The crop produced higher yields than traditionally sown crops and returned higher net earnings.

5 Hybrid varieties. Hybrid varieties typically produce R&D/demonstration yields of more than 13 t ha⁻¹ (i.e. 25 percent higher than popular Giza and Sakha varieties).
1.4 Crop residues

The corollary to the search for high yield grains has been reduction in yield of residues/by-products available – mainly the result of reduced crop height from typically 1.4 m for the traditional varieties that dominated before 1980 to less than 1 m today. The advantages for crop farmers are obvious – less susceptibility to lodging, less low-value materials to handle at time of harvest and less wastes to remove when preparing the land for the next crop. This trend has not always been welcome by livestock farmers.

High-yielding varieties producing typically 10 t ha\(^{-1}\) have an harvesting index (HI) of about 0.4 (i.e. grain yield as a ratio of total biomass yield). Thus for a national crop of 6 Mt grain, 9 Mt of residues will be produced. Traditional varieties have a lower HI and produce higher quantities of residues.

As ‘wastes’ shift to ‘residues’ and as value increases for the non-food component of the crop, issues arise for maximizing the total yield of biomass available per unit of land. Here it is that the value of markets for non-food materials may eventually take equal priority. Crop height is not directly linked to dry matter yields for, in some cases, the new shorter high-yielding varieties produce similar quantities of residues – but this is frequently more by default than design. With the growth of industrial processing (for a range of different industries - composting, livestock feed, energy, etc.) demand for relatively low-value feedstock will increase proportionally. Herein will be opportunities for crop breeding programs that may comply with the requirements of industrial feedstock.

1.5 Priorities for agricultural lands

Agricultural resources have come under increasing pressure as populations have expanded during the past 60 years and none more so than with loss of productive lands to informal and illegal settlements. The national population doubled to 36 million during the 30-year period prior to 1976, and was doubled again by 2000. Currently estimated 80 million, the population is expected to rise to 95 million by 2020. Herein are issues for economic and food security and more so given the sprawl of housing development that has arisen from informal settlement on the periphery of existing urban areas. Towns expand into the surrounding countryside and productive lands are lost under dwellings, roads, services and other non-
agricultural facilities.\textsuperscript{6} The Ministry of Environment (2007) estimated that 500,000 ha of agricultural lands have been lost during the past 20 years.

Issues are further exacerbated with the nature of illegal settlement with the lack of planning, low-rise construction and the inefficient use of lands that has resulted. These are lands that cannot easily be reclaimed. New policy alternatives are in hand to restrict illegal settlements and to encourage more efficient and planned settlement during the period of the next five-year national plan (Ministry of Environment, 2007).

\section*{1.6 Agriculture and clear skies}

Agricultural production remains a priority for national investment for the economic security required of reliable food supplies and employment and, importantly, as a means of managing demographic change. Estimated 30 percent of Egyptians continue to live in rural areas and to make a living from agriculture and rural services (the other 20 percent are city dwellers). Cereals dominate production with paddy rice grown on more than 15 percent of total cultivated lands during the summer months. Of the order 650,000 ha rice are sown annually with more than 95 percent located in the six governorates that make up the northern part of the Nile Delta (Table 1). Cairo and surrounding metropolitan areas are home to more than 30 million people and represent the most densely populated parts of the country.

Rising populations have catalyzed agricultural development with technical innovation, for example with mechanization, plant breeding, soil nutrition and crop protection that has resulted in rice yields that are amongst the highest in the world. More efficient use of land and water resources on-farm, however, has not been matched off-farm with crop and materials handling and, importantly, with processing and added value. Investment has been directed into food production, with limited interest shown for the large quantities of non-food materials produced – straw, hulls and chaff that remain after harvesting and milling the grain.

Large quantities of surplus rice straw have been, and continue to be, burned in-field as a means of quickly clearing land for the following crops. Neither equipment nor services nor infrastructure is in place to harvest the estimated 3-4 million t of non-food materials, which result from rice harvesting each year. Furthermore, markets for these materials have remained rural, traditional and small scale. As a result, there has been little incentive for straw harvesting and removal, and burning has always

\textsuperscript{6} Illegal settlements. To put things into perspective, Cairo has 81 illegal settlements that are home to 8 million people (almost 50 percent of the central urban population) and which occupy 62 percent of the Greater Cairo area. Ministry of Environment (2007) has estimated that about 24 percent of the national population are living in illegal settlements.
reflected in cost-effective advantages to the grower for cleared fields, disease control and timeliness.

For those living downwind of burning fields, however, issues of environmental degradation have arisen as crop yields have improved during the past 20 years. Noxious gases and black clouds have come to dominate the skies over the Cairo metropolitan area during the annual rice harvesting period September-October with resultant aerial pollution, damage to structures and adverse effect on human health. From the early-1990s on, these issues took a political dimension with the government demanding changes to agricultural production that would result in clear skies.7

1.7 FAO/Government of Egypt project initiative ‘rice-residues’

The Government of Egypt has undertaken a number of environmental initiatives with a host of international collaborators during the past 20 years – many of these programmes continue and some are described further in the annexes. This manual, representing a review of the agro-industrial potential of rice residues, has come from the shared FAO and Government of Egypt (GoE) project TCP/EGP/3102 ‘Rice Straw Management and Conservation of Environment’ developed during 2003-2005 and implemented during a period of 30 months from mid-2006 on. The project was completed in December 2008. Of the order US$360,000 shared investment has been made with an FAO contribution of US$315,000 and the balance provided by the government in the form of services, facilities, equipment and technical people. Funds have been invested in workshops, training, consultancies, missions and equipment (FAO, 2009).

More than 90 percent of project resources have been directed into the promotion of ‘Conservation Agriculture’, with the remainder used for exploring opportunities for the industrial use of agro-residues from rice production.

Egyptian farmers have a long history of traditional use of straw and other residues from rice production but, apart from small quantities of straw used for papermaking; this has not generally been the case with industrial

7 Aerial pollution. Issues concerning the ‘black cloud’ have been a regularly reported in the national press during the past 15 years. Whilst rice producers are traditionally held responsible, there is also recognition of the more profound effect of aerial pollution in urban areas year round. Pollutants are varied and complex with vehicle exhaust, industrial effluent, power generation, inadequate urban planning and similar at fault. Cairo and surrounding towns provide ‘thermal islands’ of infrastructure, which exacerbate the creation of smog. This is particularly worse at the end of year given prevailing meteorological conditions – and thus becomes a more profound irritant to local inhabitants. See, for example, Gulf News (2008), Kenyon (2009) & Khaleej Times (2006).
use off-farm. The project set out to change this approach with exploratory and/or commercial use of straw for composting, livestock feed, energy production (for heat, gas and/or electricity) and as industrial feedstock for a host of products (such as chemical extracts, cardboard, papers, etc.). The manual contains a summary of findings made.

1.8 Why another technical manual?

The information collected, developed and evaluated by the FAO/GoE TCP project during more than two and half years has considerable long-term value. This was recognized from the outset – and a technical manual summarizing the main agro-industrial findings was included in the original activities. Information empowers people and leads to better decision-making.

The manual provides a brief introduction to the commercial agro-residues industry and describes the potential into the next 5-10 years. Information has come from the combined efforts of the small team of consultants and technical advisors, and the limited time available for investigation. Reports by the National and International Consultants have provided some understanding of background and context and, importantly, of the many complementary (and sometimes competitive) investments underway in the country for use of agro-residues.8

1.9 Target Audience

Many agricultural and agro-industrial planning and management people will find value in the manual, but the main target audience remains:

1. **Agricultural extension workers.** People who bridge the gap between R&D workers and farmers.

2. **Professors, lecturers and teachers.** People working within the technical and academic institutes that service agro-industrial production - training the next generation of technicians, managers and industrialists.

3. **Agro-industrialists, advisors and entrepreneurs.** Mainly private sector people and those who innovate, follow markets, borrow and

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8 Project team reporting. See, for example, Hissewy (2008a), Hissewy (2008b), Steele (2007), Steele (2008a), Steele (2008b) and Steele (2008c). Copies of annual reports and mission reports are available from the FAO Representative, Cairo and/or the AGS Division, FAO, Rome, Italy.
invest - people who provide the services or make products that create employment for people everywhere.

4. People working within techno-communication networks. People provide additional information by publicizing and promoting information, targeting different audiences and similar. They will be able to select and re-draft, to illustrate and simplify, and to translate into other regional languages and, ultimately, to better inform people who have neither the time, nor inclination nor ability to use the technical manual first-hand. Provide a starting point, however, and other people will eventually become involved as new markets develop for the information available.

1.10 Guide to the manual

The manual is in three parts. Part 1 includes Chapters 1-4 that provide background, context, planning and summaries of rice production and of straw harvesting, handling and storing methods. Part 2 includes Chapters 5-10 and describes uses of rice straw some of which are traditional and popular and others offer agro-industrial potential during the next 10-years. Part 3 comprises Chapter 11 which explores investment opportunities within selected national development programs. Annex 1 and Annex 2 summarize shared investment and development work underway between the government and key donor/technical agencies. Annex 3 presents a conceptual design for investment in agro-residues industries, while Annex 4 presents contact information of people working in agro-residues utilization.
Chapter 2

Agricultural Investment in Context

Summary

The FAO/GoE TCP project has highlighted some of the key issues that impact upon the socio-economic development of the agricultural sector and, by implication, upon the development of rural communities. More than half the population remains dependent upon a viable agricultural economy, but the country has limited natural resources and remains with a traditional approach to investment (i.e. small-scale traditional technologies, inadequate information, limited shared effort and similar). Continuity of approach will create greater risk of food and economic security into the future. Improved coordination is required within the public sector and more opportunities for public/private partnerships need to be sought. This will enable farming communities and agro-industrial investors to better understand the complexity of the many issues that apply, and will encourage the development of a service sector. There is need for a shift from ad hoc investment and piecemeal industrialization in order for the country to gain greater synergy and more value from current investments.

2.1 Justification for investment

More than 95 percent of rice produced in the country comes from the six governorates that make up the northern part of the Nile Delta (Fig. 2). The practice of burning crop residues to clear the land for preparation of follow-on crops is no longer acceptable given the extent of the aerial pollution that has arisen over populated urban centers within the region. Environmental laws have been enacted to enforce rice producers and industrial services to find alternative methods for disposal of residues. Considerable efforts have been made by public authorities to explore opportunities for the use of crop residues on-farm - for livestock feed, for composting/soil enrichment and for other minor uses (such as household fuel, livestock bedding, etc.). Opportunities for off-farm industrial use – whatever the scale – have received less attention (to the extent that the sector has been largely ignored; whilst crop residues continue to be burned). Given the opportunity costs of disposing of estimated 1.5-2.0 million t of unwanted residues currently available from rice production (mainly husk and straw) in an environmentally acceptable manner, it is logical to explore
agro-industrial opportunities for use of rice residues for livestock feed, for the production of energy, for use as a soil substrate (for producing a range of high value crops) and within a handful of manufacturing ventures (for board, paper, fuels, construction and service materials, etc.).

Notwithstanding high productivity, the typical rice farmer is a small-scale producer with average land area of less than one hectare (i.e. about 2.5 feddans). Rural communities in the Delta enjoy access to reasonable infrastructure (e.g. roads, power, schools, health centers, etc.) but lack the individual resources with which to make the on-farm and, importantly, off-farm investment required. Machinery pools, farm services, technical information, R&D resources and similar are traditionally provided by the public sector. It follows that innovation and new ventures required of agro-industrial development will generally be led by the public sector which typically links R&D into pilot-scale innovation and then into markets; and, subsequently, provide the frameworks, legislation, credit facilities, tax incentives and similar that will encourage the entrepreneur to become
involved. This has been the basis for the introduction of high yielding (and short straw) varieties of rice. In the absence of easy-to-identify partners for agro-processing, the same route will probably be followed when adding value to crop residues, identifying new markets and helping naissance agro-industrial ventures into the marketplace.

With the activities of the FAO/GoE TCP project completed, it is timely to re-evaluate opportunities for investment post-project (based on the greater understanding of the mixed industrial ventures that can be considered into the longer-term). With strong public sector support there is no reason why clear skies should not return to the cities of the Nile Delta during the next 10 years; and access to new lands, increased employment and additional wealth will follow from full use of the estimated 4-6 Mt rice residues that will be available annually during this period. (Success with rice straw may also help increase utilization of the estimated 40 Mt of other solid wastes available nationally.)

In order to meet timetables of this kind, domestic and foreign investment initiatives will need to be designed, planned and implemented within some form of coordinated program. This will require vision and firm decision-making from the political sector and, importantly, a host of friendly donor partners willing to fund and share the exploratory R&D and risk-taking investments required. Findings from the FAO/GoE TCP project suggest that some of these investments are already underway (if in ad hoc manner and separated one to the other).

### 2.2 Environmental issues – way forward

The powerful environmental objectives of the FAO/GoE TCP project to stop burning and to maintain clear skies over the towns and cities of the Nile Delta will come from identifying technical and economically viable opportunities for using the estimated 4-6 Mt of rice residues produced by rice farmers every year. Developments of this kind can be encouraged with investment for on-farm and post-production technologies, and support for industries that can add value and exploit markets for the many alternative products and/or services already available (or which can be developed). Realistically, this will take place over many years.

The FAO/GoE TCP project was originally conceived in support of agro-industrial development for the opportunities, investments and/or enterprises that could be explored. However, during subsequent phases of planning, development and design, emphasis switched to activities on-farm that would boost the timeliness of crop production to enable land to be quickly cleared of crop residues and ready for the subsequent crop. The
‘conservation agriculture’ technologies, equipment and information introduced have potential to provide many of the same advantages as burning without aerial pollution. Furthermore, all farm materials remain largely within existing nutrient cycles and, whether through ruminant feed or soil incorporation, the fertility of soils is not at risk.

The environmental advantages of ‘conservation agriculture’ have been widely recognized internationally, but the practices remained largely unknown to Egyptian rice producers before project implementation. The FAO/GoE TCP project has been of value with sharing the experience of novel tillage/drilling technologies that enable crop residues to be part buried/left in situ with the following crop planted through the surface mat.\(^9\)

Logically, on-farm investment should be made in parallel to agro-industrial investment; with shifting opportunities that will best reflect the dynamics of national priorities.

2.3 Commercial exploitation of agro-residues

There is value for exploring crop residues as a commercial resource – whether on-farm or off-farm; in reality both avenues will provide access to markets that can be exploited. In some cases, these markets are already well known; in others a considerable measure of investigation, promotion and extension efforts will be required to enable new industrial opportunities to be introduced. Long-term exploitation of the sector will require shared investment between public and private sectors for access to the innovation, investment, R&D, information and enterprises that will eventually be established. These agro-industrial ventures will eventually succeed on the basis of the promotional effort made (and thus the vested interests of the key stakeholders involved), financial feasibility and environmental sustainability.

From the outset there has been logic in working from the wider perspective of national/regional good; that the advantages of current systems for rice production and crop use will provide the basis for adding value to crop residues that are currently considered a liability. In many cases this is expected to lead to improved practices – doing what is already being done -

\(^9\) *Conservation agriculture*. Project activities have enabled equipment, technologies and information to be introduced to local growers courtesy of the R&D and extension activities of the MALR/ARC Rice Research & Training Center (RR&TC) at Sakha. Demonstration plots have been established to compare new crop production systems with traditional practices with the use of direct drills purchased from suppliers in Brazil and India. More information in support of conservation agriculture practices is available: [www.fao.org/ag/conservationtillage](http://www.fao.org/ag/conservationtillage). A technical manual has been prepared to describe local experience.
but doing it better (for example with residues for livestock feed). In other cases, new ventures will be required (for example with residues for energy industries).

Notwithstanding the many findings from the FAO/GoE TCP project, these should be considered in context as simply a starting point for further investigation which, logically, will provide guidance for the longer-term post-production investment required of priority sectors that can be exploited with confidence of commercial success. It follows that all longer-term development of this kind – feasibilities, exploratory, R&D, pilot-scale and/or one-off small-scale investments – should be priority rated and findings shared that duplication and/or wasted effort is minimized. Findings from the FAO/GoE TCP project showed how poorly-informed many people in the sector were of what others elsewhere were doing nationally. The technical manual represents effort to boost information sharing that people can quickly determine existing programs and highlight opportunities for further investment.

2.4 Key issues

Key issues have been identified throughout the manual and particularly for each of the many choices for which rice residues may be used and, importantly, for the work underway within the network of discrete donor/agency/company/government partnerships that make up the ad hoc national program. In many respects, this technical manual represents a matrix of the different and inter-related issues that demand the attention of national planners. Key issues described herein help represent the conceptual framework in which the many specific politico-techno-economic decisions will need to be made during the next period. Issues include:

1. **Socio-economic directions** Hikes in food prices during 2008 and the social unrest which followed have re-emphasized the key role of agricultural investment within national planning. Fail to keep sufficient people in active employment as populations continue to rise, and further social unrest will result.

2. **Investment in agriculture** Agricultural production is under-exploited and receives insufficient investment despite the fact that 50 percent of the population remains dependent upon the sector for their livelihood. In current form, the agricultural sector will be unable to deliver the progress required to provide for rural stability. All agricultural production, off-farm, rural community and agro-industrial investment, services, resources and technologies require
review, scrutiny and/or evaluation for effectiveness and efficiency; that new directions can be selected with confidence of change for the better.

3. **On-farm versus industrial/off-farm use of straw residues** Rice production and use of rice residues is simply a case in point. Political instruction to stop burning (i.e. wasting) unwanted residues and contaminating the skies over the main urban centers provides an opportunity for re-directing R&D, funds and interest into on-farm and off-farm industrial investment. This then becomes a priority supported by the political process (for example, with funds, prompt decision-making and, crucially, external partners). Strict application of legislation remains another issue meantime (for too many people flout anti-burning laws).

4. **Market development** Value addition for a range of products from residues will enable new markets to be identified and exploited. This will raise the value of agro-residues and less will be wasted. Traders will seek to supply more raw materials for the appropriate industrial markets that will evolve. Higher value will result in increased employment for services, manufacturing and trading, and greater wealth in rural communities.

5. **Care for the environment** For a desert country with less than 10 percent of the land available for habitation and socio-economic security, the wonder is that greater efforts have not been made thus far to ensure that all national development is re-directed into environmental priorities. Government and its international partners have been involved with a mixture of environmental investment packages for more than 50 years and, increasingly so, during the past 20 years. Much of this has been piecemeal and uncoordinated.\(^{10}\)

6. **Partnerships in development** Much progress has been made with partnerships shared between government/funding agencies/technical agencies and government/private sector. Partnerships of this kind will become increasingly important into the next 5-10 years and, not least because of the current economic downturn in manufacturing and trading worldwide. With rapidly expanding populations, Egypt

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\(^{10}\) **Environmental summaries.** The Ministry of Environment annual report should be required reading for all public and private sector people investing in the country. This annual report has the potential to provide an appropriate framework for national priority choices into the next period (Ministry of Environment, 2007).
has limited time in which to accelerate planning and shift investment into those people-based socio-economic sectors that will make a difference on the long term. In addition to funds, partnerships bring consensus and confidence. Both are essential.

7. **National planning priorities** There is value with coordinating all planning required of agricultural resources, agricultural residues, agro-industrial investment and similar; and linked to the wider implications of environmental care, city/urban management, energy industries and similar; and, ultimately, to the socio-economic requirements of people for employment and wealth creation. Herein will be need for strategic decision-making.
Chapter 3
National Planning and Agro-Residues

Summary

Responsibilities for national planning rest with the public sector and with the lead ministry responsible - Ministry of Economic Development. There is no direct reference to ‘Agro-Residues’ within national planning priorities, but the ‘Agricultural Sector’ features prominently within all investment proposals as a repository of new industries, new employment opportunities and new lands. The rolling 5-year plan that has provided the basis for national planning since the early 1980s is based upon a logical framework of national priority choices that will enable the country to produce and trade on the basis of comparative advantages. The country is currently partway into the sixth 5-year plan. This includes goals established and outputs required of ‘Agriculture’ and ‘Industry’. Agro-Residues development will link into both sectors.

3.1 Introduction

National planning is led by the Ministry of Economic Development which, each year, publishes national accounts, socio-economic and socio-political indicators and reports on poverty, human development and progress with the development of the nation state and its people. Much of the latter is currently summarized in progress reporting for attainment of the MDGs. The Ministry is also responsible for the development of the rolling 5-year plans that have featured as a guide to national management since the early 1980s. National planning sets targets for key sectors including ‘Agriculture’, ‘Industries’, ‘Energy’ and ‘Transport’ – based upon the experience of the previous 5-year national plan and the focus of direction required for the next 5-10 years.

Egypt is a major trading nation in North Africa and the Middle East Regions, in the European Union and elsewhere, and the quality required of national development is reflected in the planned evolution of the Egyptian economy that will enable the country to take advantage of socio-techno-economic trends that are provided for growth and stability. The country remains competitive on the basis of the national economy and constant repositioning that provides for diversity, modernization and social progress (Ministry of Economic Development, 2009).

Agro-residues utilization will probably always remain a minor component of national planning required of the agricultural sector. With
national objectives of continued productivity, food security and employment creation, however, agricultural investment is likely to remain a leading priority. Government has been quick to promote a five-fold increase in agricultural exports with earnings of more than US$1B and an agricultural workforce expanding from 4.1M to 5.5M during the past 25-years. There is frequent reference to the need to absorb the additional 600,000 new people seeking work each year (Ministry of Economic Development, 2009).

3.2 Recent achievements

Agricultural productivity has increased during the past 25-years; with average three-fold growth for all sectors (i.e. grains, vegetables/fruits, meats, fish, poultry, etc.). Grain production, for example, has risen three-fold from 8Mt to 23Mt, and the country has become self-sufficient in selected food crops. Exports of surpluses have been made. Planning has remained an essential part of production increases with government channelling the resources of people, technologies and funds required of the R&D, extension and investment programmes involved. Additional land has been reclaimed, much of it allocated to recently trained young people (although land has also become lost to illegal settlements adjacent to the main urban areas). Notwithstanding achievements of productivity, the contribution of agriculture to GDP is declining.11

Shifting priorities for GDP is reflected in the increasing contribution from other economic sectors including manufacturing industry (17 percent), energy (16 percent), transport (9 percent) and services, finance & utilities (32 percent). The well-being of agriculture continues to remain crucial to the national economy, and a buoyant agricultural economy provides the basis for stable rural communities.

3.3 Sixth 5-Year Plan

Some understanding of design of national 5-year plans is essential; to provide the conceptual basis for encouraging further investment in the agricultural sector (and, it follows, on the exploitation/industrialization of farm materials off-farm). National plans provide a structural framework within which many different social, economic and technical investment opportunities can be considered. Plans take a broad perspective and narrow

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11 GDP & Agriculture. The contribution of ‘Agriculture’ to GDP changes slightly from year to year within the range 13-20 percent on the basis of crop production and crop surpluses that are exported. The trend, however, has been downward. During the 25 year period from the early 1980s to the present, sector contribution has slide five percent points and was 13 percent in the mid-2000s.
this into separate development strategies that set policies for the sectors involved. The general framework of the sixth 5-year plan contains:

- **Basic features.** Typical of plans of this kind, i.e. promoting and supporting - economic growth, the rights of people, the role of communities in national decision-making, preservation of national resources, political reform and similar.

- **Pillars.** That provide the basis for all development; and include the Presidential Election Programme, MDGs and the New Social Contract.

- **Development strategies.** Providing a guide to action required, for example, with fostering growth (in all sectors, but particularly infrastructure, services, building and transport), fostering export-led industries, promoting SMEs and the role of the private sector, providing better living standards for everyone, providing socio-economic incentives and structures and, important for people living in skewed geo-economic areas, encouraging regional development (i.e. promoting investment in Upper Egypt and the desert governorates).

- **Establishing goals.** Goals in support of economic and human development. And goals, moreover, that have growth rates, per capita increases, higher employment figures, expanded exports and similar that can be measured and shared.

- **Establishing development policies.** Policies that link to fiscal, monetary, investment, trade and industrial policies that will guarantee the effectiveness of strategies (that will enable objectives to be met within the five year period).

Industrial policies encompass the agro-residues sub-sector with the promotion of enterprises and services, provision of financial support to investors, establishment of industrial zoning, provision of technical skills training, licensing and similar - for the industrial development where the country is considered to have comparative advantages or where socio-economic priorities prevail (e.g. for regional investment).
3.4 Role of the private investor

Central planning within the economy has rapidly given way to an increased role for the private sector during the past 25 years. During the same period the contribution of the private sector to GDP has risen from 10 percent to more than 60 percent. This is a trend that is likely to continue as the private sector shifts into more traditional public sector activities such as power generation, water supply and similar. The public sector continues to focus upon investment in infrastructure (42 percent) with the private sector investing mainly in goods and services (63 percent). Human development projects are shared equally between both sectors.

Agricultural production is firmly private sector driven but remains characterized by small-scale farms, fragmented land-holdings, low-technologies, limited finance and limited education – providing challenges that will slow future productivity. Therein will be the challenge of shifting small-scale/low productivity systems into high productivity systems without disrupting the stability of rural communities. Herein will be need for collectivizing rural producers (into some kind of farmer groups, cooperatives, companies, out-grower schemes, etc.) in order to provide them with the benefits typical of large-scale production – without people becoming lost to the community. Modern telecommunications facilities and information technologies are expected to take an increasing role with conceptually ‘assembling’ people in rural communities and maintaining the momentum of agricultural development.

Post-production development is the domain of the private sector; and the country offers considerable potential for encouraging greater investment in agricultural services, agro-enterprises and agro-industries that are able to add value to goods, livestock and services provided by farmers. Agro-residues and solid waste management feature in selected investment opportunities, but are frequently too small to warrant special attention within national planning. Opportunities of this kind arise, for example, when searching discrete portfolios within the Egyptian Investment Portal provided by the Ministry of Industry (2009). The Portal currently describes numerous food industries seeking investment.

3.5 Sector development

The sixth 5-year plan focuses upon productive activities of commodity sectors, industry, tourism, infrastructure, communications and information
systems. ‘Agriculture’ and ‘Industry’ cover agro-residues development opportunities.

During the period up until 2012, agricultural development is expected to benefit from the reclamation of more than 4.5 Mha new lands, the establishment of 400 new villages, more than 70,000 small farms (up to 10 ha) and 300,000 large farms. More than 70,000 agricultural jobs will be created. Improved crop and livestock technologies will be introduced, and more R&D and extension centers will be established. Different crop types will take priority (e.g. sugar beet will be promoted; rice and sugarcane will be further confined; crops with high export value will be promoted – aromatics, spices, oilseed, etc.). University graduates will be encouraged into farming. More efficient water utilization is required. There is no reference to ‘Agro-Residues’ in sector planning, but there are targets for land reclamation (e.g. investing more than US$1.6B or 30 percent of total agric-investment) and creating jobs (with target of more than 5.9M).

Industrial vision is more ambitious with more than US$120B invested by 2015 with production value of US$160B and providing more than 3M jobs. The country is establishing industrial parks and corridors, providing an investment climate that will attract domestic and foreign investors and providing the policies, incentives, infrastructure and similar that will make a difference. Food processing industries are expected to absorb 15 percent of investment with the remainder in textiles, chemicals, engineering and basic metals. Again, there is no reference to ‘agro-residues’, although resources can expect to make a contribution in most sub-sectors (and also to ‘energy’, ‘transport’, etc.).

3.6 Value of farm residues

Notwithstanding the importance of national planning over short periods, issues remain for the planning required of the longer period and, in particular, for security of on-farm organic materials and/or low-cost livestock feed to the small-scale producer or farming community. Rapid industrialization and demand for straw feedstock may bring increased annual income, but may also result in nutritionally depleted soils or feed shortages for ruminants. By design, the FAO/GoE TCP project provided focus upon nutrient recycling with improved understanding for the value of ‘conservation agriculture’. No similar focus exists for community livestock feed.

Planning is required into the next 5-10 years – the period of transition that will be required for a shift from on-farm use to off-farm use of straws - that may follow the development of industrial markets for crop residues. Herein will be the wider implications of government planners/advisors that best-option choices will be made. What, for example, is the cost-benefit of a
unit of crop residues to the farmer as plant nutrients for the next crop cycle? This is likely to become more important as subsidies for chemical fertilizers are removed and prices at the farm gate rise. Equally important, what is the alternative cost-benefit of the same materials at the factory gate for the production of energy, livestock feed, compost or similar? Issues of this kind are largely beyond the requirements of the technical manual (for no comparative cost-benefit studies have been undertaken by the FAO/GoE TCP project and none are reported from elsewhere), but remain important as agro-industrial priorities arise. Given the small-scale nature of farm production, the many hundreds of thousands of people involved and their limited political visibility, there is risk that priorities will automatically shift to off-farm investment. This may severely disadvantage the farming sector long-term.

3.7 Industrial processing

Assuming increased investment in rice residues processing into the next period industrial planners, agriculturalists, entrepreneurs and others will probably be obliged to build upon existing strategies for boosting grain/food productivity and shift (from the simplicity of food security) to crop production systems that will provide more. The focus will be one of boosting employment, income generation and wealth creation in rural communities. Industrial factories (for paper, energy, compost, etc.) should be located within rice producing areas. Industrial-specific plant varieties can be developed (and not simply for rice, but all crops with industrial potential) and establish these new varieties in lands adjacent to new factories – that they will provide the raw materials required (for dry matter, silica, lignin, cellulose and other extracts). Significantly, the current national handbook describing rice cultural practices in Egypt makes no mention of non-food productivity (MALR, 2002). Herein may be requirements for a shift in thinking for public-funded R&D; and one, moreover, where decision-making may best be shared with the private sector.

3.8 Industrial choices

People need to be fed – priority; agricultural crops and livestock need access to land – supporting priority. Herein are the choices that planners and others will be required to make to address restrictions placed on the limited areas currently available in which to grow the crops required. Egypt has just 8 Mha of agricultural land available and, given that more than 94 percent of the land area of the country remains unutilized (for a host of reasons - but mainly due to lack of organic matter and access to water),
therein are firm reasons for shifting all surplus organic materials available nationally into land reclamation. Thus, the estimated 6 Mt of rice residues (and balance from the 20 Mt agricultural residues) should all be directed into composting; and the short-term gains from producing electricity (or paper, cardboard or mushrooms, for example) should be reconsidered and/or produced by other means. Land being the ultimate long-term national resource, Egypt has land in plenty but less than six percent remains productive. Access to sufficient organic materials remains a key issue.

3.9 Long-term agricultural investment

Located just two hours flying time from Europe and a similar distance from the oil economies of the Arabian Gulf, Egypt is competitively placed to shift from relatively low-value cropping (e.g. cereals, sugar beet, fodder crops, etc.) to high-value cropping (e.g. cut flowers, vegetables, fruits, out-of-season basics, herbs, medicinal plants, etc.) to meet demands in both markets. Costs of production can match the best of the sub-Saharan African and the Latin American producers, and transport costs from everywhere are beatable. With a shift from production per unit cost (e.g. Egyptian pounds, US$ and/or euro) to production based on cubic metre water or a unit of land, agricultural production must eventually shift to higher value (and added value post-harvest) cropping. The country has just $55\times10^9$ m$^3$ water available annually (more than 97 percent ex-Nile); it makes little sense to continue to produce relatively low value and/or water inefficient crops.

Again, this is beyond the basics of a manual focusing upon the use of rice residues, but the principles are the same, viz. 1. Evaluate the opportunity costs of current systems; and 2. Make choices for investment

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12 Crop residues. Issues of qualifying the amounts of crop residues available are explored in footnote #14.

13 Non-agricultural resources biomass. According to SWERI (2007) the country needs minimum of 15 Mt compost annually to meet the current demands for land reclamation. City garbage and agricultural residues provide the basis for supplies, with estimated 50% of all city garbage and <15% of agricultural residues being used. From an estimated urban population of 20M for Greater Cairo (city and satellite towns) 15,000 t day$^{-1}$ garbage is produced; i.e. about 6 Mt annually. An additional 6 Mt is available from Alexandria and other smaller cities/towns, but in increasingly dispersed quantities. At 50% recycled, of the order of 6 Mt remains available for land use. Compost from agricultural residues for off-farm use amounts to about 1Mt. Human wastes are not used constructively in Egypt. City sanitary collection in Cairo results in estimated 40 Mt year$^{-1}$ sludge available (according to SWERI, 2007), but this quantity does not stand scrutiny. (i.e. 20M people @ 0.5 kg day$^{-1}$ and 360 days yr$^{-1}$ is 3.6 Mt. Assume 50% is collected, processed, etc. more than 2 Mt sludge is probably available.) Human wastes have distinct disadvantages for crop/livestock production, but represent a considerable asset in a desert country. Estimated total organic materials potentially available nationally at 8-9 Mt. Quality harvesting and processing of organic materials could result in doubling this quantity. Sludge from Cairo is used for land reclamation in Nuberia - NW of Cairo.
and production that will provide long-term sustainable benefit and \textit{(if practical)} short-term financial reward. Here it is that shared investment between the public sector and the private sector will be essential to enable the Government of Egypt to provide the basis for long-term sustainability of environmental and financial models within which the shorter-term economic balance required of investment can be made with confidence.
Chapter 4
Materials Handling

Summary

Cost-efficient collection, handling and storage of straw and transport from farm to factory remains the basis for profitability of all and any enterprises for which rice straw remains the main input. Reliable delivery of straw of known quality will be essential for high-investment products (such as briquettes, power, electricity, etc.). Straw is collected loose for use on the home farm and local community (for traditional products – compost and livestock feed). Baling to assist with transport has been widely promoted with more than 500,000 t reported baled during 2008. More than 1,000 conventional balers have been delivered to rural communities, MALR, Ministry of Defence and others by the Ministry of Environment during the past 10 years. Straw deliveries to the RAKTA papermaking factory at Alexandria represent the only long-term national experience available. Increased demand for straw will arise from newly established briquetting and energy factories in the Delta. Limited competition between straw contractors has left farmers as price-takers, but this is likely to change during the next 5-10 years with rising values.

4.1 Straw handling, storage and delivery

In Egypt, rice straw is collected on-farm for livestock feed and composting and off-farm for livestock feed, industrial composting and soil stabilization (and until recently for paper manufacture). Straw is collected loose and/or baled for short-distance delivery (for example, for on-farm and home village use), and baled for long-distance transport (for example, for paper manufacture and industrial composting).

Straw produced from rice production has declined with the introduction of short-stem (but high grain yielding) varieties in recent years, but traders estimate annual yields of 2-4 Mt.\(^{14}\) Estimates vary and come

\(^{14}\) Crop Residues. There is a measure of confusion for the extent of the quantities of residues available from rice production; and notwithstanding the accuracy with which yield of grain is recorded each year. There is reliability with the more conservative option of 1.5-2 million Tonnes year\(^{-1}\) (Mt yr\(^{-1}\)) unwanted residues that is widely quoted, but less certainty with estimates from traders that are as high as 6 Mt yr\(^{-1}\). Given that unknown quantities of straw continue to be burned in violation of laws (and particularly in the east of the Delta where markets are weak) the reality is probably one of over-supply from a resource that is of the order 4 Mt yr\(^{-1}\) (from easily available sites). This is likely to change as large-scale
from information shared between the handful of large-scale straw traders and feedback from farming communities and small-scale traders. Large quantities of unwanted straw and straw produced at a distance from key markets continue to be burned (in spite of environmental legislation making it illegal).

4.2 Current ventures

Rice straw has limited economic value within current agricultural and industrial ventures, notwithstanding recognition of potential within the country (by both public sector advisors and private sector industrialists). On-farm straw is an essential low-value livestock feed and particularly at times of low feed supply during the annual dry season (May - December). This is the cheapest maintenance feed available for ruminants. Straw from the home crop is typically stored loose on-farm or in the village (Fig. 3). Straw brought in is typically baled (although purchases from neighbors are also typically in loose form). Similarly, all locally produced straw used for on-farm composting is handled in loose form.

Straw is stored outside without cover throughout the year and without apparent deterioration for both on-farm and industrial use (Fig. 4). There are constraints for the space available for all industrial straw users. No large-scale intermediary storage facilities have been established between farm and factory. These are likely to arise as one outcome of the specialization required of commercial materials handling into the next period; and will offer new opportunities for added-value services (and the additional employment, income and wealth that will be created).

demand for straw arises during the next period, for example for energy/electricity/fuels production, livestock feed and industrial composting. Issues are further complicated when taking the harvest index (HI) for rice as a guide to yield. Hybrid varieties with HI 0.4 can produce of the order 9M t straw from national yields of 6 Mt grain (at 10 t ha⁻¹). Popular varieties across the country with HI 0.3 will theoretically produce more straw - say 10-12 Mt. The national portfolio of all crop agro-residues is estimated at 20 Mt (but, again, this is not firm).
Fig. 3. Straw stored loose

With space severely limited on most small-scale farms, straw is stored on the roof of the farm house for convenience.

Commercially traded straw and straw transported over distances of more than 2 km is always baled. The conventional pick-up baler is widely used. Commercial straw handling, etc. remains largely the responsibility of traders and those who service them; this includes trucking companies, tractor and baler owners/operators and the large numbers of workers who make up the pool of casual labor. Straw harvesting teams are at work during the period of the rice harvest – late August to early November; as land is cleared ready for the next crop.

Constraints of time normally dominate the agricultural calendar and, given the limited value of straw, farmers generally give low priority to surpluses (over the quantities required for on-farm use.) Crops are typically harvested manually, but with the use of combine harvesters expanding rapidly (estimated more than 15 percent crop area.) Yields of straw may differ more than 20 percent given the higher cutting height of the cutter bar (when compared to the sickle). Machine harvesting leaves the straw in windrows across the field. Hand harvesting is a two-step process with the crop allowed to dry in the field after cutting, and then threshed separately (and normally by small-scale stationary tractor-powered thresher.) Straw can be left in-field or shifted off-field immediately after threshing.
4.3 Straw harvesting technologies

All commercial straw is baled prior to transport; only on-farm straw or straw shifted into the local village is moved without baling.

The RAKTA factory at Alexandria always remained dependent on a handful of elderly stationary balers with top-feed ram stroke and wire/plastic twine tie design, and straw was shipped in rectangular bales 0.6×0.5×1.5 m³ (width, height & length). Bale length varied up to 1.9 m. Mass was typically 100-120 kg/bale, but could be higher.

The conventional pickup baler is used for straw collection and handling on-farm everywhere in Egypt; and many balers have been sold/purchased in recent times (Fig. 5).
These machines produce smaller rectangular bales with dimensions 80×46×36 cm³ with mass up to 25 kg. Round bales (i.e. ‘cylindrical’ bales) are typically 1.2 m wide and 1.5 m diameter with mass of 350 kg. Both are ‘agricultural machines’ and suited for farm use; density is of the order of 100-110 kg m⁻³. Agro-industrial use requires bales that are more suited to road haulage – larger and denser. Balers produce a rectangular bale typically 0.8×0.8×2.0 m³ with density of 140 kg m⁻³ and mass of up to 400 kg. Balers fitted with chaff cutters can increase density by a further 10 percent. Conventional bales are automatically wrapped and knotted with two single twine ties. Twine wrapping provides for easy manhandling. In more recent times the large bale has replaced the conventional bale in the industrial countries where mechanical handling in-field is practical.

Conventional balers are locally made in Egypt under license to foreign manufacturers. Balers are tractor-drawn and tractor-powered, and typically pick up straw from the windrow left by the combine harvester. Given the small size of most farm crops, however, many balers remain stationary when working, and straw is collected and transported in-field and fed into the machine by hand. Balers can be one-man operated – either mobile or stationary. Bales can be collected individually from the field after baling is completed.

Manufacturing links directly to requirements of local industry – with technical assistance provided by the public sector. For example, the Agricultural Engineering Research Institute (AERI) working in support of importers and others has helped to determine the feasibility of manufacturing selected equipment for use by growers. This has included balers. Work of this kind resulted in the production of more than 200 Italian-
designed conventional balers in Egypt (i.e. primarily assembled) during the period 2001-on. Work was shared with the Ministry of Environment to help plan and provide baling services to growers, and 300 balers and 200 tractors were provided to contractors in the governorates under credit/grant facilities supported by the Ministry. Support for straw harvesting continues to the present day with 294 pickup balers and 40 semi-mechanical balers provided by the Ministry of Environment to the MALR/Mechanization Department in 2008. Field days and training have popularized baling in rural communities and more than 570,000 tonnes straw were reported harvested in conventional bales in 2008 (Hissewy, 2008b).

Furthermore, the Ministry of Environment provided 185 balers and 70 tractors in support of the AOI Kader factory at Sharkia and helped bale and ship more than 70 tonnes straw in 2005. Additional support with equipment has been provided to the Ministry of Defence with supply of 90 tractors and trailers for transport of bales (Ministry of Environment, 2007). State farms in the Delta are reported to have the large round bale under trial.

Bale reception and handling at the RAKTA factory in Alexandria was designed around the rectangular bales produced by factory-owned balers. Factory reception can (and does) easily accommodate the smaller conventional bale – although these bales require more handling off-truck, into store, on to conveyors and into choppers. There is also more twine used/wasted. Bale reception could easily be changed to accommodate any permanent shift in bale configuration, mass and/or dimensions – to enable existing bed feed/chopper equipment to continue to be used. Bales stored at the RAKTA factory represented the only large-scale storage facilities seen during the period of the FAO/GoE TCP project. Further information to describe storage, factory and paper-making is contained in Chapter 10.

4.4 Economic factors

The cost effectiveness of current systems of handling straw for use on-farm is interesting, but of little relevance to long-term issues of industrial use. Models, specifications, systems and similar typical of 2007, in which farms remain small (average less than 1 ha), the farmer remains the key source of labour and materials remain low-value, are unlikely to change quickly. Only as and when the conventional bale is replaced with larger bales (and the bale becomes too heavy to handle without a tractor loader) will issues of cost effectiveness arise.

More efficient packaging, handling, transport and delivery (and, where applicable, storage) is the key to the profitability of commercial industrial ventures that use straw as a raw material. The economic models required of location of farm straw, location of factory, use of intermediate storage
depots, use of modern equipment for packaging, economic truck loading and handling pre-factory have generally not been determined locally – or, if they have, this information is generally not in the public domain.

Most straw required for the RAKTA paper company was baled, transported and stored during the period August–December (of the order of 20 percent of supplies month\(^{-1}\)), with the remainder purchased out-of-season. Prices quoted by traders varied, but were of the order US$15 t\(^{-1}\) for 10,000 t unit/purchase in 2007. Farm gate prices compare unfavorably with others reported for supplies to factories established at Dakahlia and Sharkia with the assistance of the Egyptian Environmental Affairs Agency (EEAA) according to Roic (2006). With financial support of the order US$89,000 from the Canadian International Development Agency (CIDA), the EEAA has been able to offer farmers a farm gate price of US$14 t\(^{-1}\) baled straw. CIDA funding also provided subsidized purchase prices for balers to the first 50 farmers participating in the project. Transport from farm to factory was undertaken by Queens Service, a quasi-military company.

The RAKTA factory always purchased straw on the basis of lowest cost. Given that the factory was the only large-scale purchaser in the eastern Delta, prices across the industry remained low and the farmer remained a price taker receiving US$0.60 bale\(^{-1}\) (or less if distance from the factory was greater). Straw contractors plan to keep prices low; and prices varied by 1-2 percent from a median base, although after January each year, prices tends to rise (but again, by less than 10 percent, and of the order US$1.00 t\(^{-1}\)).

At 10 bales t\(^{-1}\) and purchased at US$0.60 bale\(^{-1}\), the farm price for straw destined for the RAKTA plant was US$6.00 t\(^{-1}\) baled. Selling price to the factory at US$15 thus represents more than 200 percent mark-up to cover transport and profit. Small differences in price, etc. arise from moisture content of the straw; with dry straw of the order 80 percent of the weight of wet straw (but with no indication of actual moisture content provided by traders or farmers for use when negotiating prices).

In Dakahlia Governorate the price the farmer received for straw was US$6.00 t\(^{-1}\) (i.e. US$12 from a typical farm area of 0.4 ha). Cost of baling and collection was US$4-6 t\(^{-1}\). Traders sold baled straw for US$20 t\(^{-1}\) (with a margin of US$8-12 t\(^{-1}\)). Most traded straw is used for composting. Estimates suggested 10 percent of straw in the governorate was burned because no large-scale markets existed.

All pilot-scale plants, R&D experimentation and quasi-exploratory industrial ventures underway have established straw supply models. Two such models identified by the mission included: 1. World Bank/bio-fuels electrical power proposal (2007); and 2. AOI Kader Company proposal
The AOI Kader Company study targeted compost manufacture. Some financial figure for separate straw collection equipment and services are shown in Table 2.

### Table 2. Indicator straw collection financial figures

<table>
<thead>
<tr>
<th>Item</th>
<th>Value (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional pick-up bale</td>
<td>4,500</td>
</tr>
<tr>
<td>Tractor (60 kW)</td>
<td>20,000</td>
</tr>
<tr>
<td>Truck (road, 15 t)</td>
<td>12,000</td>
</tr>
<tr>
<td>Trailer (road, 10 t)</td>
<td>6,000</td>
</tr>
<tr>
<td>Transport (10 t straw, 60 km)</td>
<td>5</td>
</tr>
<tr>
<td>Labor team (10 people/day)</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: Ashraf Fikry Abaza, Straw Trader

### 4.5 Key issues

1. **Resource utilization** An estimated 1 Mt of straw is used annually for traditional farm use – composting, livestock feed, etc. and particularly by low-income people in desert areas. Large-scale demand from agro-industrial processing is likely to place risk upon supplies; with the poorest sectors of rural communities losing access to traditional low-cost resources. Protective measures may be required to ensure that 10-15 percent of rice straw residues continue to be available for traditional markets.

2. **Modern procurement technologies** Crop collection, handling, storage and delivery to markets are based upon systems that were first devised more than 40 years earlier in support of the RAKTA paper manufacturing plant at Alexandria; or those that make use of the conventional bale (a package that was originally designed for manual handling). There is no information to show that this model has been re-evaluated in recent times to boost efficiency of materials handling. Access to new technologies–electronic management, transport, crop packaging/handling and preparation/pre-processing is required. Opportunities for introducing large-rectangular and/or

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18 *Straw handling and collection studies*. Neither of the two studies was evaluated by the FAO/GoE TCP project team and thus feedback for viability, cost, etc. has been strictly limited. A copy of the AOI Kader proposal ‘Study of Collection, Baling & Transport of Rice Straw’ was obtained from the Company. It was in Arabic. An industrial straw collection study of this kind would provide the basis for a useful agro-industrial/engineering MSc thesis (if this has not already been done) and would provide some valuable pre-investment information in the short-term. Cost? Estimated US$5,000 for 2-year study at a local university.
large-cylindrical bales typical of forage conservation/handling in the industrial countries should be further explored.

3. **Negative economic value of materials** Because of perceived low value, little effort has been made to explore and cost the most effective means of collecting, storing, pre-processing and/or delivering straw to factories. Logistical and economic systems have been devised over the years that have enabled a cartel of four large-scale straw traders to dominate the market and set prices for purchase of supplies in the Delta.

4. **Supply and demand** Prices are likely to follow classic supply and demand curves as demand for straw increases. Demand is unlikely to rise in the short-term. (Demand could decrease further, for example, should larger-scale agro-industrial processing options become lost.) Prices are, however, likely to increase in the long-term as demand from other markets is developed.

5. **Establishing prices** Traders have determined the purchase prices of straw on an historical cost-plus basis; linking delivery price at the factory gate to the costs of collecting, packaging and transport. Farmers have few options for choice of sale to traders and have become price-takers. This is typical of conditions of market oversupply. (Essentially, there have been insufficient outlets for the estimated 1.5-2 Mt of unwanted rice residues available annually.)

6. **Employment/wealth creation** In a country of 80M people (and growing of the order of more than 2 percent annually) and largely living on the wealth created from just 10-15 percent of the land area of the country, social stability and wealth creation comes from the sensible use of all existing resources. There is logic in adding value to the estimated 4 Mt of residues available from rice production; and if not commercially, then within the socio-economic support required of the public sector with the use of all organic materials (*agricultural and others*) that may help create productive new lands. Herein is the basis for a logistics study and the introduction and use of modern handling, transport and packaging systems that will enable crop residues to be moved/used cost-effectively (for the long-term national good).
Chapter 5
Soil Enrichment and Composting with Rice Residues

Summary

Compost is the main traditional outlet for small-scale rice producers with estimated 20 percent of all home-grown straw being made into compost for local use. Ministry of Agriculture and Land Reclamation has widely promoted the production and value of compost. With the reduction of state subsidies for manufactured fertilizers, small-scale production is likely to increase. Rice straw compost is also produced on commercial-scale, although quantities remain unqualified. A handful of large-scale factories have been constructed in recent times, and the simplicity of the methodologies of production (i.e. concrete pad & materials handling equipment) adapted for local use. Issues of markets and pricing arise, and returns on investment may be low. A hike in prices for straw during the next 5-10 years for a host of off-farm markets may place pressure on low-cost livestock feed and organic materials for compost making on the home farm. Development of this kind could be detrimental to small-scale farmers. Fertile land is the ultimate national resource in a desert country. Recycling organic materials represent the basis for land reclamation.

5.1 Context

Rice straw can be used as feedstock for compost or ploughed directly into the soil as a source of organic nutrients. Compost provides greater benefits when incorporated into the soil, with nutrients in the organic materials immediately accessible to the growing plant. There is less value from compost that is spread on the surface of the soil, and nutrient content will be lost. Composting in rice growing areas of the Nile Delta is fragmented and small-scale and, in total, has minor impact upon the extent of the quantities of rice straw produced each year. Compost is produced for sale by the more commercially astute farmers, but there is little indication it was being used outside the local district.

Industrial-scale composting from rice straw has begun to gather investment momentum, but remains isolated as exemplified by the two factories that have been established in Dakahlia Governorate in the Delta by the AOL Kader Factory group. Industrial composting of city refuse is well established in Cairo by a number of processors. Both producer groups are aware of the potential for advanced packaging, marketing and high-value sales of compost (for example, into public- and private-sector urban
markets). There has been no reference to vermiculture composting during the period of the FAO/GoE TCP project investment (and the value therein of accelerated composting and the production of dried worm meat/milling mixtures for use as a constituent of poultry feed).

5.2 Land reclamation

Largely outside the remit of a technical manual focused on use of rice straw, national policies for the reclamation of land remains a key issue for long-term large-scale use of rice residues (and organic residues of all kinds). Land reclamation has remained a cornerstone of government agricultural policies since the early 1950s (with public investment dating from more than 50-years earlier with the completion of the first Aswan Dam). Target areas feature in all 5-year development plans of recent times. In the 1980s land reclamation was estimated at 30 percent of all public investment. During the late 1990s, costs rose to estimated US$2,150/ha land reclaimed. During the 35-year period 1952-1987 estimated 800,000 ha land was reclaimed. Reclamation is a complex and time consuming activity with considerable de facto regression, for example as trials fail, land reverts to desert, inefficient conservation is followed, topsoil is lost, illegal settlements occur, growers default on loans, etc. Reclamation barely keeps pace with decrease in croplands, with one estimate suggesting annual losses of land of about six percent (Anon., 2009).

Compost has properties that will help with the reclamation of desert lands - and extending agricultural areas.\(^{19}\) Areas of reclamation have been identified adjacent to the Delta in North Sinai for use of rice straw compost, and NW of Cairo (near 6th October City) for use of compost from city wastes. Government currently has a target of more than 4 Mha of newly reclaimed land by 2017. More challenging technical issues arise with reclamation of saline soils or calcareous soils.

5.3 Current ventures

In recent times, the Central Administration Extension Services (CAES) of the MALR has promoted a number of technical packages to farmers for use of straw including effort to boost the production/use of compost. Based upon decomposed mixtures of rice straw, livestock manure and crop wastes, compost is a low-cost, high-value and easy-to-use alternative to burning straw. Burning, however, provides a number of well-defined advantages (such as rapid land clearance, weed seed kill and

\(^{19}\) New lands. INP (2001) report success of the government initiative Agricultural Policy Reform (APR) with the expansion of cropped land areas from 4.7 Mha to 5.25 Mha during the 1990s (and more than 10 percent increase in agricultural incomes and improved nutritional intake).
reduced disease carry-over on crop residues), some of which can also be gained with well-rotted compost. The key issue is one of management; that people learn the skills required (whether on farm- or industrial-scale).

A questionnaire was prepared by the Rice Research & Training Center (RR&TC) seeking to determine the extent of the knowledge available to extension workers on use of rice straw (with a similar survey planned for farmers). The draft questionnaire was technically advanced and made no reference to the economic opportunities involved for composting and/or for a host of other uses (such as livestock feed, mushroom production, silage making, etc.). This raised issues for the value of feedback available given the difficulties that many people would face when answering the questions.

The AOI Kader factory company invested US$4.5M in two large-scale straw-to-compost plants in 2005 based on feasibility studies that included 'social obligations' towards investment.\footnote{Location of factories. There was also reference to two compost factories in Dakahlia Governorate at a meeting held with the Deputy Minister of the governorate, MALR (mid-2007). This suggests two additional factories coming on stream. Behind investments of this kind there is always reference to the role of the different agencies linked to the Egyptian Military with responsibilities for land reclamation and, importantly, to the role of the Ministry of Environment with providing funds and technical assistance for investments of this kind.} Funds were provided by the Arab Organization for Industry. The factories were constructed at El-Qorain and El-Kalitara in El-Sharkia Governorate and occupied an area of 25 ha. More than 1,000 people have been employed. Factory production for Year 1 was expected to be 160,000 t compost from 300,000 t rice straw (and other constituents), but was not achieved. Of the order 50,000 t of straw was processed over two years. The main obstacles to progress have been markets and pricing. Both factories have proven to be unprofitable (Hissewy, 2008b).

The Egyptian Company for Solid Waste Utilization (ECARU) is one of the largest solid waste handing companies in the Middle East and operates six sorting, recycling and composting facilities in Egypt and Libya, including three on behalf of Cairo City Governorate. It manufactures 10,000 t yr\(^{-1}\) compost at the El-Nubaria factory with intake of the order 100 t straw day\(^{-1}\), plant residues, livestock manure and similar agro-wastes. Five types of solid/liquid organic fertilizers are produced by the company with physical and chemical properties that reflect the different source materials (MSW and/or agro-residues) and markets (ECARU, 2008).

Compost from city wastes has different properties compared to that made from agricultural residues. City wastes contain hazardous materials, substances, chemicals, etc. which should be restricted from direct entry into the food chain. Furthermore, there are markets for organic composts, for
specially treated materials/composts and for different end-uses. AOL Kader is exploring these higher value markets further in an effort to ensure plant profitability (but recognizes the social/national good of recycling organic materials for use, for example, with land reclamation). An urban-based composting factory was constructed in Sadat City in 2008 with design output of 20,000 t compost rising to 50,000 t during the next 5-10 years (Hissewy, 2008b).

5.4 Composting technologies

5.4.1 Small-scale/on-farm

Compost making on garden-scale provides little opportunity for using large quantities of rice straw. Farm-scale composting has similar limitations but, following CAES recommendations, farmers are able to build stacks with sufficient capacity and bulk density to promote decomposition and temperature build-up (Fig. 6). Extension workers and farmer-leaders provide regular and routine training opportunities for others within their community.

Fig. 6. Compost on-farm

Cycle of six months produced friable and easy-to-handle compost from a mixture of rice straw and cattle manure. This will be spread on the home farm.

About 100 t compost is produced each year on the 240 ha farm belonging to the El Sharraby Family. Raw materials are typically 50 percent rice straw, 25 percent cattle manure and 20 percent wheat straw with the remainder made up of green wastes (such as sugar beet tops). Small
quantities of purchased nutrients are added including urea, super phosphate, sulphates and nitrates. A triangular-shaped windrow is built – 6 m across the base and up to 5 m in height (which slumps to 3 m during a rapid decomposition period of three months). The windrow is turned every two weeks and kept liberally sprinkled with water (depending on the ambient climate – more water is used during the summer months). Materials are handled with the use of a tractor loader and workers with shovels.

By local standards, the El Sharraby farm is a large one, but the amount of straw used compared to that available on the farm is less than 20 percent total – estimated 500 t. The remainder is available free-of-charge to neighbors (for livestock feed or composting) or, more pragmatically, simply burned on site. There are no local markets available in the region for sale of large quantities of rice straw – and of the order 2,000 t of straw is lost each year.

5.4.2 Commercial-scale/off-farm

The FAO/GoE TCP project team visited the El-Nubaria factory on the Alexandria-Cairo Desert Road. It comprised reception unit/sieves for screening waste inputs, large concrete pad for constructing and mixing windrows, and associated units. It operated with a selection of specialist materials handling and windrowing equipment capable of handling large quantities of bulk material (Fig.’s 7 and 8). Organized labor worked alongside equipment moving materials and watering, cleaning, bagging, etc. as required by hand. Factory intake was mainly agro-residues and the company produced what they called ‘Nile Compost’, which is sold mainly for use with horticulture, gardens and orchards (i.e. high-value markets). The factory collects and bottles concentrated solutions of humic acid for sale for selected horticultural use (ECARU, 2008).21

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21 Humic acid. Is one of the major components of humic substances. These are dark brown and form a major constituent of soil organic matter. Humus content largely determines the chemical and physical properties of the soil; and agricultural potential.
Fig. 7. Windrow machine
Special equipment is required to handle industrial compost-making; the windrow is regularly turned and watered to ensure even decomposition.

Fig. 8. Rotary screen
Industrial compost is screened prior to bagging, to produce high quality uniform mixtures that contain no tare.
5.5 Economic factors

All compost produced by the El Sharraby farm is used on the home farm; none is sold. Estimates showed costs of production of the order US$6 t\(^{-1}\) of compost made. Selling price for compost is up to US$12 t\(^{-1}\), but markets only exist adjacent to areas of land reclamation – and this does not apply to the governorates of the central and northern Delta (where the El Sharraby farm is located).

Routine budgeting analysis of on-farm compost production undertaken by the FAO/GoE TCP project has indicated a gross margin of US$3 t\(^{-1}\), which implies a gross margin of 13 percent. In principle, the alternative is economically attractive particularly if no investments in fixed assets are required to perform the composting operation.

It remains to be determined whether there are viable compost markets within the main urban areas – for sale of filtered, bagged and labelled compost. Market exploration by the El Sharraby farm suggested that earnings would not be covered by income given the extent of the credit charges involved. Equipment, area preparation, etc. was estimated at US$30,000 most of which would need to be borrowed – and at prevailing 8 percent interest rate. Much would depend on the reliability of markets; and better information and real-time enterprise evaluation is required.

Industrial production costs appear equally difficult to balance with the reality of the market. The initial selling price of US$32 t\(^{-1}\) for bulk sales from the AOI Kader composting factories in the Delta has proven too high and compost did not sell well. This resulted in price reductions to US$27 t\(^{-1}\) in 2007. Competition from compost manufactured from city waste remains an issue given the estimated US$8 t\(^{-1}\) state assistance to processors for collection and removal of wastes from the city. Transport distances are also shorter. With similar production costs to rice straw compost, city compost producers are able to sell their product ex-factory at a competitive price of US$22 t\(^{-1}\) for bulk sales.
5.6 Key issues

These link one-to-the-other and include:

1. **Markets** Most markets remain traditional and local; with compost destined for use on the home farm or by farms in the neighbourhood. It may be that most local growers (i.e. small-scale, quasi-commercial, etc.) neither appreciate the nutrient value of the compost nor find the time to make it. There are opportunities for promoting more compost making; particularly if this can be done on community-scale (with shared commercial investment).

2. **Community-scale manufacture** One or more community demonstration enterprises are required to explore opportunities for producing bagged compost for sale into urban markets. This can be done, for example, with loans courtesy of the Business Development Services Center Support Project (BDSSP), University of Alexandria. Similarly, a vermiculture-compost demonstration enterprise should be explored and/or established.

3. **Industrial-scale manufacture** The ECARU El-Nobaria factory is well-established with a willingness to share information. It is essential that the private sector be further encouraged into large-scale compost manufacture; to provide sufficient basic materials for reclaiming new agricultural lands. Insufficient information was available to determine the extent of raw materials and processing capacity already available within straw producing areas. With annual residues intake of 360,000 t, 1 Mt of unwanted straw could support of the order four ‘El-Nubaria-scale’ factories. Issues of location and transport will arise.

4. **Quantities of straw** Notwithstanding promotion and widespread uptake of composting - traditional composting methods and demand for compost by farmers are unlikely to result in use of large quantities of straw annually; estimated less than 10 percent of total available. Large-scale manufacturing is required to boost demand (but, again, issues of capacity will arise and need to be better determined).

5. **Organic material resources** Whatever the extent of the organic materials that can be made into compost, the country/industry will
remain irresponsible if it fails to capture the value of these materials for use with extending the areas of land that can be made available to agriculture. There is a need to promote the value of the environmental investments involved by composting/reclaiming new lands for long-term national well-being.

6. **Land reclamation** There is a scope for large-scale investment by the public sector in the industrial manufacture of compost from straw to be used in land reclamation. This will be particularly important for rice-producing areas adjacent to urban areas (where burning can result in severe aerial pollution) and where there are short transport journeys to areas of land that are being reclaimed. Once methods are established, financial frameworks have to be in place to encourage the private sector to become/remain involved. More information is required to determine the status/opportunities for large-scale production of compost for land reclamation programs.
Chapter 6
Livestock Feed from Rice Residues

Summary

Livestock production is an important component of domestic agricultural industries with a national herd of 17-18M ruminants fed on the basis of rotational clover and crop residues. Rice straw is a crucial ingredient of livestock feed during the second half of the year. Estimated 25 percent of this is chemically treated with urea and/or ammonia on the farm to boost nutritional value and palatability. The extent of industrial livestock production remains to be determined, and thus the extent of commercial-manufactured livestock feed also remains unknown. Both are likely to feature in long-term agricultural planning for Egypt. The small-scale livestock producer depending upon low-cost feed is likely to face issues of cost/supply into the next period as competition for straw from other users arises. Some measurements of security may be required to protect the sector.

6.1 Context

Egypt has a livestock population estimated at 17-18M ruminants. The country faces considerable market opportunities with increasing demand for animal proteins, dairy foods and similar livestock products, but remains unable to expand livestock populations because of insufficient grazing land and livestock feed. Livestock are raised intensively as a secondary industry on six percent of the national territory – the Nile Valley and Delta. Nomadic herds are found elsewhere, however, but much of the production does not enter the domestic commercial trade. Given the ability of ruminants to consume products that are not in direct competition with food for people, therein are opportunities for ensuring that all appropriate lignocellulose residues produced nationally are directed into ruminant feed. Current developments with rice suggest that less than 25 percent of straw

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Livestock populations. Estimated 4M buffalo, more than 4M cows, 9M sheep & goats and 0.95M camels, of which more than 60 percent are in the north of the country. Demand for animal proteins is expanding of the order 2 percent annually with daily per capita consumption currently 18 g day\(^{-1}\) and expected to increase to 24 g day\(^{-1}\) by 2015. Imports make up for short falls in meat and dairy production – estimated at 35 and 20 percent, respectively, each year. Given a rapidly expanding human population and limited productive land, demand for these foods will always outstrip supply; and the country will always import them.
available is used for livestock production and then in largely ad hoc manner (i.e. small-scale, on-farm, non-industrialized, etc.). The MALR and others have made considerable efforts over the years to encourage the use of crop residues for livestock feed for small-scale livestock producers. Many of the recommendations provided by Nour (1988) have become part of traditional practice; and remain valid for small-scale production into the foreseeable future.

6.2 Current ventures

Rice straw as feed and bedding for livestock is the most important market for rice straw currently available, and an estimated 75 percent of all rice straw used goes into livestock feed. Estimate total use is 3 Mt (but these are figures that can be challenged). Straw is fed raw (i.e. as harvested), treated with chemicals and/or mixed with clover and other additives. Rice straw is a valuable source of maintenance rations for ruminants during dry seasons from May-December, when there are no alternative feeds available that time. Rice straw is the cheapest feed in the country and of the order 25 percent the price of wheat straw (the preferred choice of cereal roughage for livestock).

On-farm feeding covers two periods each year, viz. ‘green feed’ season December-May, and ‘dry feed’ season June-November. Seasonality is based on the harvest cycle of Egyptian clover (berseem), which is available during the first half of the year. Various mixtures of feed are recommended by the MALR during both seasons, with the boost in N content of straw that results from chemical treatment of value when clover is in short supply. Mixtures may contain a host of different feeds such as sugar beet pulp, molasses, urea, vitamins and mineral additives. The country has a total digestible nitrogen (TDN) shortage of more than 4 Mt annually - thus recommendations for N-enrichment treatment.

Livestock farmers are regularly trained on the production of improved straw treatment by the MALR based upon the resources of eight centers offering technical services (including ammonia gas treatment) in the northern rice producing areas. Services are mainly directed to small- and medium-scale livestock producers. Larger-scale livestock farmers (i.e. those with more than 500 cattle) tend to rely less on rice straw and more on home-grown fodder such as maize. But, in reality, all livestock farmers feed rice straw at some time during the year.

During the period when clover is available, rice straw is fed without chemical treatment in mixtures with clover (of the order 4:1, respectively, straw to clover) and sometimes with other additives. Moisture content of the
newly harvested clover can be as high as 70 percent and mixing with rice straw helps prevent unwanted gas production in the rumen.

Small quantities of rice straw are used for bedding – for penned or housed livestock. The absorption properties of rice straw are inferior to those of wheat straw (although here again, only small quantities of wheat straw are used for bedding – given its value as feed). Estimates of quantity remain unknown. The mixture of manure and rice straw is a valuable input to the compost heap – for on-farm recycling of nutrients.

6.3 Technologies

Livestock rations are largely outside the scope of reporting required of the technical manual, but it is useful to note the two most popular chemical treatments giving the importance of domestic livestock industries (and their dependence on rice straw). The MALR continues to promote:

- **Urea** 1.5 percent solution of urea applied to loose straw with the use of a watering can; heap covered with plastic sheet for a period of up to 10 weeks after treatment.
- **Ammonia** Stacked/loose straw covered with plastic sheet and injected with ammonia gas; sealed and left for 10 weeks treatment before use.

Feedback from local farmers to the FAO/GoE TCP project suggested better results from, and more confidence in, ammonia treatment. All mixing, applications, covering, movement and feeding are undertaken by hand; stock are penned and fed in troughs. Stocks are also fed in-field following the crop harvest (for all crops – wheat, barley, sugar beet, clover and rice) and graze crop stubbles for short periods. One typical ration for a mob of 45 penned buffalo was 4 feeds daily of a mix comprising 50 kg NH₃-treated straw (i.e. two bales), 30 kg fresh clover and 2 kg purchased concentrates/additives (comprising a mix of maize, salt, cotton seed pulp, wheat husks and calcium carbonate powder). A summary of small-scale urea/straw treatment in plastic bags is available from FFTC (2007).

Just the one non-chemical treatment is recommended by the MALR – seeding barley on to heaped straw (and also on to baled straw) and watered to encourage germination before feeding. Here again, there are recommendations and the reality of the practices that are actually followed; barley seeding was only mentioned by MALR technicians and not by farmers. Seeded bales were seen in use, however, on a number of farms (Fig. 9). A useful summary of many of the main technical issues involved is available from Nour (1985) including treatments, nutrient content, digestibility, additives, mixtures, ensiling, etc.
Industrial processing of straw (with or without additives) to manufacture livestock feed offers potential, but no information was provided/obtained to help determine either demand or economic evaluation of product development. Given the low-nutrient value of the nuts, meals, cake or granules that would result from processing raw/untreated straw, the costs involved and the unknown markets (for what scale of livestock producer?), investors would need to evaluate costs and demand as one means of evaluating risk. Are livestock ranched in the country? Is there intensive cattle production for milk and/or beef (i.e. industrial cattle production)? Background information of this kind remains to be determined.

Issues of straw quality arise as a result of storage practices – improved straw storage/facilities generally provide better quality feeds with improved nutrient composition, increased nitrogen free extract and in vitro digestibility of dry matter and organic matter. Given the dry nature of the prevailing climate, opportunities for mycotoxin contamination are less likely to arise. Al-Mamun, et al. (2002) explored some of the many options involved with a useful description of straw prepared for feed.
6.4 Economic factors

The FAO/GoE TCP project was unable to source information for off-farm (i.e. commercial-scale) processing of livestock feed, and findings were limited to recommended MALR practices for treating locally-grown straw on-farm. In Dakahlia Governorate farm prices were higher than quoted earlier at US$3 t\(^{-1}\) baling and US$6 t\(^{-1}\) transport, or US$33 t\(^{-1}\) purchased from a trader. Costs of treating rice straw with NH\(_3\) were US$11 t\(^{-1}\), which was 50 percent subsidized by the MALR. Labor for straw handling on-farm was estimated US$2 t\(^{-1}\). Income, by comparison, is exemplified by sale of an in-calf 3-year old buffalo for US$80 (from the mob of 45 head described above).

A case study undertaken by the FAO/GoE TCP project in Dakahlia Governorate showed that 1 ha of rice straw generated additional income of US$58 to the farm, with a gross margin of 39 percent. Similar case studies at Sakha Research Station revealed gross margins of US$43, US$3 and US$42 t\(^{-1}\) of feed, respectively, for straw treated with ammonia and urea, and preserved as silage. Gross margins, respectively, were 124, 5 and 80 percentages. The figures illustrate the financial advantages of on-farm production of livestock feeds from rice straw.

6.5 Key issues

1. **Strategic industry** Small-scale livestock producers dominate the industry; if and when industrial-scale straw processing industries begin to dominate markets for rice straw, measures have to be in place that will help protect the low-income livestock farmer – that this sector will continue to have access to low-cost feed/rice straw.

2. **Industrial productivity** Much of livestock production is based on penned cattle, hand-feeding and/or scavenger feeding. Cattle are kept in poor and unhygienic housing. Veterinary care is strictly limited. The extent to which livestock farmers adopt recommended feeding and management practices remains unknown, but a casual assessment by the FAO/GoE TCP project suggests productivity is far lower than it should be. Higher productivity will provide for investment in improved feed processing industries – including enhanced rice residues-based feeds.

3. **Commercial-scale livestock feed production** Information to describe the extent of this industrial sector and its potential remains unknown. Clearly, higher cost feeds will need to sell into industrial sectors that
could recuperate additional costs; with smaller quantities likely to be sold to small-scale livestock producers. Given increasing demand for meat and dairy products nationally, investment in industrial-scale production will already have been considered within national development strategies. Further investigation is required to determine the demand that may arise for rice straw/hulls from commercial livestock feed manufacturers.

4. **Rice varieties** Varieties of rice introduced during the past 25 years produce less straw than earlier ones—these are the ‘short-straw varieties’ that have helped boost grain yields. Given competition for straw from industrial processors into the next period, there may be opportunities for a shift to high yielding long-straw varieties, to provide for livestock farmers (and other markets for straw).
Chapter 7

Food from Rice Residues

Summary

Whether as a constituent of compost/soil amendment, as a protective blanket under (or through) which plants can be encouraged to grow or as a substrate for mushroom production, straw provides an excellent basis for boosting food production. Composting is covered in Chapter 5. This section briefly considers the use of straw as a substrate – seeding the mushroom spawn required directly into specially-treated straw media.

7.1 Soil-less horticultural production

Horticultural crops can be grown under soil-less conditions – but the technologies, management and investment required can be demanding (when compared to normal in-soil production). Working with the University of Suez and as one small contribution towards the Montreal Protocol in support of reduced use of methyl bromide as a soil sterilant, UNIDO has an investigation underway to explore soil-less/straw based production of strawberries and other high-value fruits in 2 ha of straw-bed.\(^{23}\) Findings are shared with the 5-6 largest horticultural producers/exporters in the country. Whatever the outcome of the R&D trials, they are likely to have limited impact on the quantities of rice straw produced in Egypt in the short-term. Longer-term developments could, perhaps, provide for soil-less/straw bed high-value production of selected horticultural crops in desert areas where organic matter is unavailable.

7.2 Mushroom production

7.2.1 Context

Mushroom production represents a ‘win-win’ opportunity for food producers in Egypt. From a brief review of the opportunities involved, there are no immediate disadvantages and everything to be gained from promoting both small-scale and household-scale production and,

\(^{23}\) Methyl bromide. At one time methyl bromide was widely used as a sterilant for mushroom production – sanitizing the growing media between batches of mushrooms. Damage to the atmospheric ozone layer that resulted has led to it being banned in many countries (with restrictions placed on international trade where it continues to be used in contravention of international laws).
importantly, commercial medium-scale production. Sufficient technical knowledge and information and, essentially, experience is available locally - and if not always in Egypt, then in neighboring countries (such as Cyprus and/or Jordan). Issues will arise with extending mushrooms into local cuisines (for these foods are not widely eaten in Egypt) and of encouraging market development – but both issues can be accommodated. The nutrient content of mushrooms is well known (i.e. high protein) and they have particular characteristics and benefits that complement other foods typically eaten in Egypt. There is much to be gained from promoting the production and increased consumption of mushrooms by people throughout the country.

7.2.2 Current ventures

Small quantities of mushrooms have been produced commercially in Egypt for more than 20 years, but demand has consistently outstripped supplies with the result that large quantities of mushrooms have been imported annually. Only recently has commercial-scale production begun to expand with 3-4 large producers competing successfully for the estimated US$1M import market in 2006 (i.e. reduced 50 percent from the early 1990s). Local production is estimated at 360 t yr\(^{-1}\) and will be sufficient to match imports during the next 5-10 years. All commercial production is based on the button mushroom (\textit{Agaricus bisporous}) called ‘champignon’ in Egypt. Several new investments are planned or underway.

It is difficult to grow button mushrooms on small scale, and production has not generally been encouraged by MALR/Central Administration Extension Services (CAES). Instead, communities, farmers and others with access to rice straw are being encouraged to produce oyster mushrooms (\textit{Pleurotus ostreatus}) – for home consumption and for sale into local markets. Costs of production are low. Current production is estimated 650-750 t yr\(^{-1}\). By comparison Jordan has a domestic mushroom industry producing of the order 10 times Egyptian production and currently valued at US$10M. A large-scale commercial producer will typically have 1 ha of growing sheds and produce an estimated 500 t annually of button mushrooms (and similar). Shared ventures with Jordanian producers may be a logical means of stimulating commercial development in Egypt.

Reporting from the FAO/GoE TCP project highlighted the value of small-scale mushroom production units for farm households, rural communities and village enterprises; and the training effort made with more than 1,800 people (i.e. farmers, housewives, extension specialists and training specialists) over two years. Issues raised have included access to
markets, teaching people how to preserve, cook and eat mushrooms, and access to sufficient supplies of materials (Fathy, 2008).

7.2.3 Technologies

Button mushroom production typically follows the adoption of internationally-recommended technologies using bed production systems in specially prepared and environmentally-controlled growing houses, the use of sanitized growing media, the purchase of spawn from recognized sources (i.e. international suppliers – mainly from the EU), strict seeding and production regimes and harvesting on a strict 97-day cycle. Thus in one year growing houses will accommodate 3-4 crop cycles. The media mix differs between species with different materials, straws, fibres, manures and other additives included depending upon the production characteristics required. The media in the beds are used just one-time, and then discarded and replaced with new media. Spent compost/media can be used as livestock feed or an organic fertilizer. These materials are easy to handle and can, with skilled marketing, be sold at higher (i.e. premium) prices compared to the best of the natural compost mixtures for horticultural use (although current demand is strictly limited and markets will need to be developed in Egypt).

Hygiene and sanitation issues are firm – straw must be treated to remove/kill all unwanted pathogens (that the mushroom crop is not contaminated with unwanted fungi). Straw required for oyster mushrooms has to be immersed in water at 90º C for 1 hr before use - before bagging, seeding and sealing. One kg spawn is mixed with 25 kg rice straw and has a growing season of 90 days. From this of the order 5 kg of mushrooms will be produced.

The MALR/CAER has been promoting small-scale mushroom production to rural communities for more than four years, providing the training courses required and the materials required (including spawn, bags, technical assistance, etc.).

7.2.4 Economic factors

The economics of production vary with scale. Button mushrooms sell for US$6 kg⁻¹ retail in Egypt and cost about half this to produced (with buildings, equipment, etc. depreciated over more than 10 years). Costs of borrowing funds for investment in Egypt are high (and typically more than 10 percent), although mushroom growers can begin small and expand by re-investing as crop is sold. Small-scale producers of oyster mushrooms have little or no investment costs apart from home labor. Bagged production can
be hung just about anywhere that is secure from the elements and vermin. The 5 kg produced (from the 25 kg straw, 1 kg spawn and 97 days investment described earlier) will cost about US$1 to produce (i.e. US$0.20 kg⁻¹) and will sell for four times this in local markets.

7.2.5 Key issues

1. ‘Win-win’ enterprise opportunities There are no real issues against boosting both production and consumption of home-grown mushrooms. The industry represents an excellent means of providing employment, income and wealth. Increased consumption will further boost vegetable protein intake and enhance local nutrition. Everyone - everywhere in rural Egypt should be producing mushrooms on small-scale for use in the home and for village markets.

2. Challenges To promote the industry; to encourage more people to produce mushrooms; to encourage development of the post-production sector for the use of irregular size, damaged and otherwise useful fresh produce that cannot be sold fresh (and is currently discarded).

3. Straw resources Such is the strictly limited size of domestic mushroom production and the small resources of straw consumed/required – that boosting mushroom production will make no difference to reducing the quantities of straw available annually.
Chapter 8
Energy from Rice Residues

Summary

Rice straw is an excellent source of heat energy and used for heating and cooking in the home in many countries worldwide. Where large quantities of materials are available, where the logistics of handling are cost-effective and where favourable opportunity costs apply, commercial heat can be produced. Thus far, energy from straw has remained pilot-scale in Egypt, although a number of proposals for larger-scale exploitation has been suggested. Two agency-funded gasification plants have been constructed and gas provided to local villages. Generation of biogas has been promoted by government for more than 50 years, with a number of small demonstration units established. With widespread access to modern power/fuels in recent years, many of these earlier investments have become obsolete. A large-scale straw pelleting plant was commissioned in 2008 for sale of pellets into export markets. Herein may be potential for a thermal power station based on straw utilization. Issues of co-generation and of sale of power at acceptable levels are likely to arise.

8.1 Context

Demand for energy is rising rapidly with population growth and enhanced living standards for the majority people. Egypt remains heavily dependent upon petrochemical fuels – natural gas (42 percent) and crude oil (53 percent) – with the balance from hydropower, coal and renewable resources. Exploratory effort is underway to develop alternative options but, notwithstanding interest in bioenergy fuels, the sector has insufficient resources to provide for more than five percent of total primary energy demands (from the efficient use of all crop residues) according to Saeidy (2004). An additional 15 percent of total energy demand is expected to be provided by other renewable resources by 2020 (from current investments in wind- and solar-power technologies24) with total sector providing 13,500 MW power. Inefficiencies in production, transmission and utilization of power and, crucially, subsidized fuels leads to high levels of waste.

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24 Power sources. Solar radiation provides 1,900-2,600 kWh/m²/yr depending on location; and winds along the coast of the Red Sea provide average annual wind speed of 18-36 km/h (with power flux of up to 1,000 W m²) according to GEF (2009). Resources are encouraging.
according to the Ministry of Environment (2007). Efforts are in hand to reposition and modernize energy industries within the country, but bioenergy resources are unlikely to become a significant contributor.

The energy content of dry rice straw is of the order 15 MJ kg\(^{-1}\).\(^{25}\) Residues from rice have been widely exploited for heat in rice producing countries worldwide, for example, many hundreds of thousands of people continue to cook on specially designed rice husk stoves. Others use gasification and biogas systems on household-scale and others explore community-scale electricity generation from locally produced biomass.\(^{26}\) Findings from the FAO/GoE TCP project showed no systematic use of rice residues for energy in households in the Delta, although R&D and pilot-scale ventures have attracted attention and some agency-led investments have been made. Small-scale use for home heating and/or cooking was suggested by some sources, but this is more a reflection of earlier practices and before rural areas was electrified and/or supplied with relatively low-cost LPG gas in transportable bottles.

Transformation systems for gas or electricity production from crop residues remain to be exploited, and a number of energy-producing units have been established and/or suggested. The information available to the FAO/GoE TCP project, however, provided a glimpse of the fluidity of the ideas involved. For example, the Egyptian State Information Service (ESIS) described four bio-fuels projects in planning for mid-2008 as shown in Table 3.\(^{27}\)

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25 Energy content rice straw. Energy content varies with a number of factors much of which depend on the extent of weathering, leaching, etc. (i.e. chemical depletion) and on the basis of variety. ‘Grey’ straw is less corrosive to boilers and plant. It is a useful thermal fuel with 150 percent the calorific value of wood chips, 60 percent coal and 30 percent natural gas. A key disadvantage is low density and, given the small-scale nature of production in Egypt, disbursement over large areas.

26 Biomass energy. To provide one example – Thailand. According to the Bangkok Post (2001) the Thai Government was reported on target to produce of the order 300 MW of electricity from more than 80 Mt of biomass/crop residues by 2006 – of which more than 96 percent was due from rice residues – with subsidies of US$50M available from the state.

27 Shared ventures. The ESIS (2008) described the establishment of a dedicated Egyptian-Sudan joint company with which to exploit these opportunities, which further suggests shared locations and access to Sudanese resources (e.g. land, water, residues, etc. in addition to expertise). The small quantities of rice straw ex-Egypt and the R&D nature of bio-fuels extraction from lingo-cellulose/straw-based residues highlight the costs and economic risks for small-scale power production.
Table 3. Pipeline projects for bio-fuels production

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Output (t)</th>
<th>Investment (US$ M)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-diesel</td>
<td>250,000</td>
<td>200/year over 3 years</td>
<td>250,000 jobs will be created.</td>
</tr>
<tr>
<td>Bio-diesel</td>
<td>200,000</td>
<td>650</td>
<td>Inputs of 1 Mt straw annually.</td>
</tr>
<tr>
<td>Bio-ethanol</td>
<td>100,000</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Bio-ethanol</td>
<td>120,000</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>


The energy sector continues to be widely explored in Egypt (and worldwide) giving increasing demand for petrochemical fuels and corresponding hikes in price. With limited domestic resources, Egypt, like many other countries, will be obliged to work within the prevailing market prices. In the short term, this will lead to the implementation of policies that will reduce demand, improve efficiencies, encourage the use of more thermal-efficient fuels (e.g. natural gas) and, importantly, encourage a switch to renewable resources (particularly wind & solar). Developments of this kind are already underway. See, for example, Ministry of Environment (2007).

Two additional easy-to-understand sources of information to describe straw/energy scenarios for Thailand and Denmark, respectively, can be found at Gadde, et al. (2008) and Anon (1998). Findings are of value for Egyptian conditions. El-Haggar, et al. (2002) of the American University Cairo (AUC) promoted the value of ‘complexes’ as a cost-effective means of directing rural residues/wastes to the most suitable outlet/use, including energy.

8.2 Electricity production/power generation biomass

If sufficient biomass resources are available and costs of production can reflect in the selling price of the power derived, then opportunities may exist for investment in biomass-to-power plant. During early 2007 an Egyptian newspaper article made reference to exploratory discussions between the Government of Egypt, World Bank and a French consultancy company for the establishment of a pilot-scale biomass/electricity plant in the Delta. The article described an investment of US$10M and the availability of loan funds. It was not certain where in the Delta the plant
would be located. No technical information was available at the time (and thus no indication of demand for straw resources, power produced, costs, etc. could be made). No further reference was subsequently provided during the following 18 months. Articles of this kind promote and encourage ideas, and provide a means of testing interest on the part of the energy industry. Whether there is basis in fact continues to remain speculative.

The AOI Kader Company also included electricity from biomass within their portfolio of studies during 2004-2006 (a period that pre-dated the GoE/World Bank initiative). The company had stopped working on the study following advice from the state electricity company that the selling price for power would need to reflect prices typically charged from conventional power utilities. The AOI Kader study had shown that production costs would be too high to meet these (largely subsidized/municipal) prices. The company had cited high costs for harvesting and transporting rice straw, and for manufacturing the pellets required for industrial feedstock. (Presumably, the GoE/World Bank study will also have made similar observations.)

Costs of power production feature wherever renewable resources (i.e. non-petrochemical fuels) are considered. There is a measure of entrenchment that existing thermal power utilities with low-cost electricity will remain the standard into the next period; and utilities in Egypt are no exception. With economic reform underway and subsidies being removed, Egyptians are likely to find future costs of power much higher than today. This is the same wherever novel sources of energy are being considered. Matsumura, et al. (2004) reported electricity costs of US$0.21/kWh from rice residues from R&D effort in Japan – exactly double normal costs (and this with heat recovery of 80 percent combined with 10 percent cogeneration with heavy oil). Domestic Egyptian power generation with biomass fuels is unlikely to better these results. This raises issues for alternative prices for power from different sources and the incentives that may be required to encourage exploratory and/or R&D investment. This study was never made available, although the straw collection study undertaken by the Company was shared with the FAO/GoE TCP project team. Whatever the potential for straw/biomass electricity potential, opportunities should be seen in perspective with, for example, more than 93 percent of domestic electricity derived from thermal power and the remainder largely from hydropower. Commercial biomass resources will remain insignificant into the next period no matter government objectives to generate 20 percent of total domestic power from renewable sources by 2020 (with solar and wind resources dominating; and national hydropower resources already more than 90 percent developed) according to the Ministry of Environment (2007).
During 2008, a joint-Austrian-Egyptian initiative resulted in the establishment of a straw briquetting plant at El Sharkia in the Delta with investment of US$26M. The plant has design output of the order 50,000 t month$^{-1}$ and is expected to become fully operational by mid-2009 with the bulk of sales to the EU. A second plant is planned for Dakahlia on the basis of the success of the first according to Hissewy (2008b). Clearly, the success of briquetting plants may encourage others to plan investment in power generation. Cost of briquetting in Egypt has been estimated at US$27 t$^{-1}$(GEF, 2009). Saeidy (2004) explored briquettes as a bio-fuel in rural areas and suggested that the average farm household had access to more than 2.2 t crop residues annually with heating potential of 38 GJ. This is more than required for domestic purposes. Collectively, local resources could be used for small-scale industries such as crop drying and intensive poultry production.

Linked firmly to straw as a source of thermal energy are the properties of firing/burning in controlled environment. Working with straw pellets (12 mm diameter and 10 mm length) in a fluidized bed, researchers at Mansoura University, Egypt extracted 96 percent energy content over a range of operational conditions (Okasha, et al., 2005). Pelleting increased density 10-fold than that of raw straw. Low CO and NOx emissions resulted. Charcoal can also be produced for export or sale into lucrative recreation markets (Fig. 10).
Fig. 10. Charcoal production

Control airflow into the mass and charcoal is produced; in this case with waste timber from replacement orchard trees. Selected charcoals are used for filter manufacture.

8.3 Biogas production

It was not clear to the FAO/GoE TCP project of where developments in biogas technology (i.e. anaerobic digestion) are centered in the country. The project team was unable to visit a biogas plant, and feedback from meetings, etc. provided little information of value. In addition, conflicting information existed. There was no information, for example, to determine background, number of working units available, capacity, investors, production parameters, location, costs, etc. Invariably, there was reference to investments made by the Ministry of Environment and the involvement of the Egyptian Military in R&D-scale activities.
The MALR/Soil, Water & Environment Research Institute (SWERI) has long been responsible for ‘Wastes-to-Biogas’ activities as part of their soil enrichment and plant nutrients programs with methane/biogas as a useful output (SWERI, 1994). Much of this work has been undertaken at the Training Center for Recycling of Agricultural Residues and is described further by TCRAR (1999). Annex 2 provides some additional information. In more recent times SWERI has considered biogas production within an ‘Integrated Community Waste Recycling/Model Village’ approach, seeking to encourage rural self-sufficiency. An assessment of Sinbo Village in Gharbiya Governorate provided a comparison for costs of nutrients from organic manures and purchased fertilizers, for example, and made reference to biogas production; but failed to provide information of outputs, costs, value, etc. for the biogas produced (Shimi, 2005).

A pilot-scale plant provided with donor assistance from the People’s Republic of China, for example, was established in the Governorate of Dakahlia in 2005, and has annual intake of 11,000 t straw. Biogas has been piped free-of-charge to residents living close to the plant in an effort to raise interest, demand, etc. for this source of energy. Charges for gas are pending. Profitability has not been raised as an issue. Minor modifications to existing LPG cooking stoves are required (e.g. changing gas jets, etc.) before households can use the gas. Operating parameters remain unknown. Opportunities for new investment also remain unknown. Issues of straw supply were raised, with demand for access to modern/large balers.

8.4 Gasification of rice residues

The extent of energy production from gasification of rice residues in the country remains minor/pilot-scale. Two plants have been constructed with technical and financial assistance from the People’s Republic of China in Tami El-Amdid, Dakahlia Governorate and at Kafr El-Assazy in Sharkia Governorate according to Hissewy (2008b). Costs are reported at US$420,000 and US$375,000, respectively. Buildings and equipment dominated investments, at 50 percent and 35 percent, respectively. Plant intake of straw is estimated at 11,000 t yr⁻¹. The gas tank holds 330 m³. Gas produced is piped into the houses of local people – 300 houses were suggested – for cooking (not lighting). People currently receive the gas free-of-charge.

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28 Straw catchment area. Assuming 10 t ha⁻¹ straw produced and 50 percent available for off-farm use, the most effective catchment required for supplying of the biogas plant exemplified will be an area of 8.9 km radius around the plant – and plant demand would dominate local supplies of straw leaving little available for alternative uses.
8.5 Key issues

1. **Qualification of energy information** Notwithstanding two-years of activities, the FAO/GoE TCP project was unable to determine the viability of rice residues for energy production. Logic suggests that this information is available in-country given the establishment of a number of pilot-scale ventures, and an effort has been made by GEF (2009) to provide comparative energy production parameters. This is recommended reading for all energy investigators. Publication and sharing information will provide guidance for industrial and/or in-home use of bio-fuels.

2. **Straw demand power production** Small-scale gas production will not consume large quantities of straw, but the establishment of a community gas unit may result in strong competition for local resources of straw. Household-scale and community-scale gas units require relatively high investment for low returns. Management of small-scale gas units can be demanding. Large-scale electricity production can be expected to consume significant quantities of rice straw (and/or rice husks) and increase pressure upon local supplies across 2-3 neighboring governorates. Issues of competition are likely to arise, which will increase demand and thus raise costs to buyers. This will be counter-productive for systems that are only marginally profitable.

3. **Energy from bio-fuels** The relatively small quantity of materials available, exotic nature of conversion, high investment levels and high risk warrant caution for investors and advisers when considering marketing opportunities for straw/bio-fuel/power. Value addition may be more practical for better-known and lower-risk organic nutrient markets in the longer-term.
Chapter 9

Novel Uses of Rice Residues

Summary

Search the bibliographies and the Internet and a wealth of alternative uses can be found for residues from rice. Many are opportunistic and novel, others are futuristic and may depend upon public sector support for development; and yet others have been demonstrated as technically sound and commercially viable. Much depends upon local markets for the products that can be made and/or services offered and, importantly, on the support from investors (including the host state) when introducing new ventures. ‘Novelty’ within the context of the products listed here refers to use/manufacture in Egypt. An assessment is made for suitability for use in Egypt to assist with priority decision-making. Small-scale manufacture of marketable products should be supported in rural communities.

9.1 Liquid/alcohol fuels

A number of technologies exist for converting rice straw into ethanol – for use as an extender for petrochemical transport fuels or as industrial feedstock. Worldwide, investigations are underway to produce alcohol fuels from crops and forests (to combat rising oil prices). Of the technologies available gasification, acid hydrolysis and enzymatic processes currently offer the most promise – all are capable of converting biomass residues into alcohol. Technical and economic barriers exist that reduce the competitiveness of alcohol made from lignocellulose materials such as rice straw (when compared to alternative sugar/starch crops). For example, reporting from Japan by Ando, et al. (1987) comparing ethanol/rice straw and ethanol/bagasse production showed advantages for the latter. Earlier interest in shared investment MALR/ARC/JICA for a venture of this kind has not been carried through to fruition. See Annex 2.

9.2 Mats, baskets and tubes – agriculture/home use

Straw mats, tubes, etc. represent an easy-to-make and easy-to-use low-cost product with a host of uses including control of erosion, clean ground working conditions, temporary wall dividers and housing, wind-breaks, etc. Egypt has long history of high-quality carpet making; straw mats would represent the low-cost end of the market. Products would be entirely
machine-made and to any dimension, shape, configuration and purpose required. Many would find use as ‘agricultural consumables’ for crop treatment, storage containers (with external wire surrounds), livestock housing and similar. Geotextile mats/blankets can be pegged out over exposed land to control wind-blow and to encourage re-vegetation (protecting the growing plants/grasses). Small size high-quality straw mats make an excellent alternative to the beach towel. Tubes can be made from ‘straw netting’ or may simply be made from ‘rolled-up’ mats. Filled with sand, soil, etc. they can be used for stabilizing land, etc. or as a planting media for horticultural crops.

9.3 Mats, baskets and tubes – marine use

Marine barriers, blankets, bales and similar products are a first-choice option for containing oil spills at sea. The sector is experience-specific and technically-demanding, but many of the products are manufactured from cereal straws (and similar materials) as a low-cost option for mopping up oil on seawater, cleaning beaches, etc. and are relatively easy to discard/destroy following use. Exploration of this industrial sector will be required but, given the geography of the country astride main shipping routes between Europe and Africa/Asia, products of this kind are almost certainly already in demand (and stored ready for use at strategic locations at both ends of the Suez Canal and in the Red Sea).

9.4 Chemicals and other extracts

Rice straw contains varying quantities of cellulose, lignin, silica and other chemicals, all of which can be extracted and/or combined into different products as part of the extraction process (but with varying degrees of effort and investment). Several products are already under investigation in Egypt according to the findings of FAO/GoE TCP project, as follows:

1. **Agricultural chemicals** The Soil, Water & Environmental Research Institute (SWERI) reported laboratory investigations to produce ammonium sulphate and super phosphate to provide the basis of an agricultural fertilizer or chemical feedstock industry. Similar R&D activities had lead to laboratory-scale production of phosphoric acid. Patents protect these processes. No information was available for costs, investment, markets, domestic/imported alternatives, etc. SWERI suggested a pilot-scale ammonium sulphate plant would cost US$350,000 and a commercial-scale plant of the order US$10M.
2. **Silica** Silica is used in a variety of industrial processes. Semi-burned rice straw contains more than 60 percent silica, which can be extracted at 99 percent dissolution efficiency on the basis of stoichiometry, reaction time and leaching temperature according to Zaky, et al. (2007) of the Central Metallurgical R&D Institute of Cairo. Similar work was seen at the Rice Mechanization Center (RMC) with use of R&D apparatus for extracting silica from straw. The unit batch processed 70 kg loose straw, and tilted to allow the silica in solution to be decanted through a valve set in the base of the container. Waste solutions and lignin resulted. The latter has potential as a fuel. It can also be converted into active carbon. RMC referred to potential markets in the petrochemical industries of the Middle East for silica and active carbon, and confirmed both practical and economic viability, but no supporting information was provided.

3. **Herbicides** The Nawwar Company Cairo offer to provide an herbicide extract developed from waste black liquor from pulping rice straw (Nawwar, 2009). Specifications remain vague and referred to as mixtures of waxes, carbohydrates and inorganic materials, but the herbicide tested satisfactory on rice crops. Currently it is sold in 25 kg bags with minimum 100 kg purchase required.

4. **Soluble crude protein** Pre-treatment of rice straw with a combination of alkaline and high pressure steam and the use of locally isolated fungi enabled researchers to boost enzyme activity and to produce yields of more than 32 percent crude protein under laboratory trials at the National Research Center, Cairo. The use of results of this kind for boosting commercial livestock feed, for example, remains unknown (El-Masry, 1982).

5. **Algae control** Egyptian researchers at the National Water Research Center have successfully controlled filamentous algae in open waterways with the use of rotting straw. The decomposing process releases a complement of different chemical compounds (including hydrogen peroxide) which eliminate existing algae and prevent new cellular growth. Application for use with potable water, irrigation channels and transport waterways (e.g. Suez Canal) have been suggested (El-Ella, et al. 2007).
9.5 Board manufacture

The manufacture of boards and panels from straw has well-proven technical credentials from many straw producing countries; and, for a time, these products and systems successfully competed with board, etc. (i.e. similar products) made from wood chips. For a country in which all timber products are imported, wood-substitute products would appear to have a reasonable future. This was the findings of two studies undertaken by the AOI Kader Factory for the production of MDF and HDF materials/products. Copies of their studies from 2005 were provided to the FAO/GoE TCP project. Scale of manufacture is important and the studies referred to US$40M investment required for minimum production 250,000 m³ board products annually. The company also highlighted bagasse as a valuable source of fiber/pulp; and the estimated 50,000 m³ available from local resources.

9.6 Straw mulches

Afforestation, green belts and orchards feature within national planning for both environmental protection of lands and, importantly, for climate moderation – much of which will be community based (and/or crop or plant based). Mulches are widely used in all dry land horticultural and tree cultivation systems and in many agricultural production systems. Mulches help control weeds, provide a suitable micro-climate around the plant (and particularly when small and vulnerable to water stress) and reduce the need for herbicides and irrigation, and thus help lower costs. Natural mulches are environmentally appropriate and eventually breakdown to provide organic nutrients. Suitable mulches can be made from rice straw. Researchers at the National Research Center, Giza reported up to 100 percent weed control with mixed straw/plastic mulches and 85-98 percent control with straw alone on stands of 15 year citrus trees. Large quantities of straw are required (to provide depth) and this raised costs of transport. Use of home-produced straw as mulch, however, has significant cost advantages over the use of plastic and herbicide alternatives (Abouziena, 2009).

9.7 Construction materials

Rice straw can be used directly or indirectly as construction materials. When rice straw is burned the ash (RSA) produced is highly pozzolanic and suitable for use in lime-pozzolanic mixes and for replacement of Portland cement, according to work undertaken at the Construction Research Institute.
and the Minofiya University, Egypt by El-Sayed and El-Samni (2006). One-hundred and fifty kg of RSA is produced for every t of straw burned (and has 82 percent silica content). Thus 2 Mt of straw will produce 300,000 t RSA annually. RSA has potential as partial replacement in cement pastes (for the manufacture of concrete). Setting times increased the higher the content of RSA in water/cement ratios. RSA satisfies the requirement of selected ASTM classes and can be used as a cement replacement material. This has advantages for use of local materials and for reduction in costs; value is added to materials previously considered waste.

Straw bales provide a fire-resistant and thermally efficient construction unit that is considerable less expensive than traditional materials, for example, when building a rural home. Worldwide there are numerous examples of houses that have been built satisfactorily and safely from straw bales. Straw bales can be used for wall systems; they replace conventional bricks, concrete or wood cladding. Treatment against vermin/pests and cement rendering provides a semi-permanent structure. The house will still require conventional foundations, roof and finishing materials. There are considerable savings on heating and/or cooling costs over use of more common insulating materials (many of which are made from petrochemicals). Further information is available from CRC (2009).

Straw house design. Fifty easy-to-follow house plans have been provided by Balewatch (2009).
### Table 4. Summary of novel uses and recommendations for investment

<table>
<thead>
<tr>
<th>Uses</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid/alcohol fuels</td>
<td>Not recommended. Given rising national demand for liquid fuels in the foreseeable future and constraints on domestic land available, continuing investment in the R&amp;D, etc. involved is not justified given the small quantities of ethanol that would result and the investment/effort required of a straw/ethanol industry.</td>
</tr>
<tr>
<td>Mats, baskets and tubes for agriculture/home use</td>
<td>Recommended. This is an easy-to-invest industrial sector from which a host of low-cost products can be made. What is surprising is that these products are not already available.</td>
</tr>
<tr>
<td>Mats, baskets and tubes for marine use</td>
<td>Not recommended short-term. Opportunities may exist, but need to be determined. Begin with agricultural/household straw mats and extend thereafter.</td>
</tr>
<tr>
<td>Chemicals and other extracts</td>
<td>Training R&amp;D-scale recommended. R&amp;D investigations are the domain of scientists, engineers, technicians and others, and the R&amp;D budgets that support them. Herein are teaching opportunities for students and others. Commercial-scale not recommended. There was little evidence to describe the commercial markets that exist for the more sophisticated chemical extracts, but clearly agricultural chemical fertilizer markets are important. The quantities of straw required remain unknown. Short- and medium-term development seems unlikely.</td>
</tr>
<tr>
<td>Board manufacture</td>
<td>Recommended for longer-term investment. The AOI Kader proposals show potential, but at significant high investment levels. Investment at this level requires a foreign partner; with the confidence that this brings to domestic production (and not least from improved partnerships with government agencies).</td>
</tr>
<tr>
<td>Straw mulches</td>
<td>Recommended. Given reporting from local sources, straw mulches are already in use and/or under investigation nationally. Further, given national proposals for afforestation, regeneration of lands, green belts, etc. (including 100 km around Cairo) manufactured straw mulch packs may have a role. Technical investment requirements are strictly limited.</td>
</tr>
<tr>
<td>Construction materials</td>
<td>Recommend follow-up to obtain more information on the value of RSA in locally-made cement mixtures and/or construction industries. This can be obtained from the authors referenced and/or local cement manufacturers. Demonstration housing project recommended. Houses built from straw bales are not typical of Egypt, but this should not detract from small-scale R&amp;D investigation.</td>
</tr>
</tbody>
</table>
9.8 Key issues

1. **Novelty and investment** The considerable portfolio of exploratory desk-top study and R&D investigation illustrates the effort made by local institutions and workers to identify products that can be manufactured from rice straw. Much of this appears to have remained in the domain of the R&D worker (for publishing, etc.) and there is little information to describe ideas, systems and/or products shifting into the public domain. Commercial investors may neither be aware of products explored nor markets that can be exploited.

2. **R&D investment** National institutions should continue to explore promising opportunities for extracting, using and/or modifying rice straw, contents and/or products that may link into domestic manufacture and/or exploit domestic and/or international markets. R&D has a useful teaching/training function.

3. **Scale of production** Large-scale production of novelty products is more challenging than small-scale production (and involves funding, access to partners and risk). Notwithstanding this, however, investment in novel products is underway (e.g. straw pellets for export). Information to describe these industries is not in the public domain. All large-scale production opportunities should include desk-top and/or pilot-scale pre-feasibility evaluation (including economic appraisal).

4. **Small-scale production** The manufacture of simple products (e.g. straw mats, pots, blankets, etc.) can be introduced with limited investment, and will suit small community enterprise development. Industrial scale of this kind requires limited investment and risk; and is recommended. (For example, it may be possible to produce mushrooms on small-scale in baskets/mats made from rice straw – if issues of infection/quarantine can be controlled.)
Chapter 10
Paper Manufacture from Rice Straw

Summary

Paper, cardboard and similar materials can be successfully manufactured from cereal straws. There are numerous examples of viable private sector straw pulp enterprises available worldwide. The RAKTA Company of Alexandria is a public sector venture with more than 40 years industrial experience of paper manufacture in Egypt. The company is one of two producing paper from natural fibers/pulp in the country. The Alexandria factory is currently working to full production capacity, but faced issues with profitably when selling paper from straw against low-cost imports. Environmental issues have risen to prominence in recent times. In 2008 this resulted in closure of the straw/paper manufacturing line.

10.1 Current ventures

The General Company for Paper Industry (RAKTA) produces and trades in printing paper and carton products. The Company is currently 81 percent owned by Chemical Industries of Egypt with the remainder shares held by government and other public entities. It comprises eight plants on a 225 ha estate located 24 km east of Alexandria. The company has a website describing all aspects of the company, activities, manufacturing, products and planning into the next period (RAKTA, 2009a).

Until recently, the Company used of the order 150,000 t clean rice straw bales annually for the manufacture of writing paper. From this an estimated 25,000 t of pulp was produced. This represented 40 percent of annual output. Rice straw was one of two sources of fibers/pulp used by the factory. The straw/paper line was closed mid-2008 mainly as a result of waste discharge that could not meet current environmental standards (but also for economic reasons). This was not the first time (Anon., 1999) and suggests that the straw/paper line could re-open at a future date. Notwithstanding current closure, the experience of the RAKTA factory remains important for future opportunities that arise with the use of more

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30 **Straw quality.** RAKTA set specifications for the supply of straw for paper-making. Straw should be dry (with less than 15 percent MC), bright in color, fresh with no green or bacterial contamination, etc; to be delivered in wire-tied bales with mass 50-140 kg and dimensions of the order 140×50×50 cm³. They also placed restrictions on rice varieties that were acceptable and stipulated demand at 114,000 t yr⁻¹ (RAKTA, 2009b).
modern straw/pulp technologies in Egypt. The RAKTA factory was established in stages during the late-1960s and early-1970s as the result of Soviet investment and (of concern to the environmental issues of the early 1990s on) with the use of the Soviet technologies of the period. It has always been a ‘dirty’ factory.

Prior to closure rice straw had comprised the smaller proportion of factory intake, with a gradual shift to recycled/waste paper in recent years for greater profitability (and without the environmental issues that arose from processing straw). With urban housing from the city now encroaching and encircling the factory site, issues of continuing with (out-dated and heavy) industrial manufacturing within densely populated areas have arisen. Further, factory waste streams/emissions are no longer legally acceptable and, notwithstanding profitability and the socio-economic value of providing employment for more than 2,050 workers, high land values may lead to plant closure in the short-middle term.

Alexandria is at the NW edge of the Delta and straw had to be transported over long distances. Straw was delivered by traders who purchased, baled and stored it and generally dominated supply lines. Straw reception systems were generally ad hoc and antiquated.

10.2 Technologies

A description of the Alexandria factory has been provided by Njie (2007) as technical assistance to the FAO/GoE TCP project. RAKTA (2009a) has also provided a useful technical description of their Alexandria factory. Note the traditional three-stage processing chain; viz.: (1.) Crop reception; (2.) Fiber extraction/pulp production; and (3.) Paper manufacture. That is, straw reception (i.e. chopping, cleaning, etc.) through batch digestion in a series of 10 separate 5 t units and a pulp extraction cycle of 4.5 h (i.e. charging 0.75 h, cooking 3.5 h and discharge 0.25 h) to bleaching, filtration and cleaning. Paper is manufactured in an adjacent rolling and drying plant. A similar plant is owned by the same company in Upper Egypt and continues to manufacture paper from bagasse.

A shift to short-stem rice varieties during the past 20 years has resulted in lower fiber production (per tonne of straw) and thus more straw required per tonne of pulp produced; and thus more straw required/handled at the factory. The factory generally used five tonnes of straw to make one tonne of pulp; this is 60 percent more than required with the earlier long-straw varieties. Fiber length is not uniform throughout the length of the straw. Generally, fibers are longer closer to the ground, which raises additional issues for harvesting with combine harvesters when compared to harvesting by hand. The higher the stubble left in the field, the more likely that the
longer fibers will be lost to the manufacturer. To augment for fiber length, quantities of imported wood fiber were mixed into the pulp before the paper was manufactured.

Apart from rising land values from encroaching suburbia in Alexandria, the main technical issues affecting the factory continued to be those linked to the production of toxic waste streams (called ‘black liquor’) from digestion and associated pulping/bleaching processes. These waste materials were not treated to required standards prior to factory closure, but discharged by pipeline into the Mediterranean Sea 1 km off-shore. Of the order 1,500 m$^3$ effluent was discharged each day notwithstanding effort by the company and technical assistance from UNIDO and others to comply with legalities. Discharge has been illegal since 1994. A UNEP case study (1986) described effort to improve the environmental performance of the plant. It showed chemical recovery value US$3.6M (i.e. 13 percent of market value of pulp sold) and recommended silica sludge utilization/disposal for brick manufacture.

Similar paper-making factories constructed by the Soviet Union in China and Indonesia have long since closed as the result of environmental issues, and the same has now happened in Alexandria. Industrial processes are continually appraised for technologies upgrade, and the RAKTA factory has been no exception. Changes to production have been made, for example, with replacement of Soviet equipment with more efficient German-made equipment, but the discharge of wastes from straw processing has proven uneconomic/unviable.

10.3 Economic factors

A number of economic issues continued to arise at the time that the straw/paper line was closed. This included:

- Underlying land values for the Alexandria factory, which are bringing pressure for factory closure and replacement with real estate.

- Paper manufactured from straw has become unprofitable in recent times. Only the recycled paper/fiber mill had remained profitable. Management estimated that the factory lost of the order US$35 t$^{-1}$ writing paper manufactured from straw.

- Paper from recycled paper/pulp costs US$90 t$^{-1}$ to manufacture; with comparative cost from straw of US$800 t$^{-1}$ (notwithstanding the higher quality of this paper). And costs increased the more the externalities have affected production (such as implementation of
environmental legislation). Recycled pulp/paper continues to be sold mainly for packaging.

- In 2005/2006 the factory enjoyed a trading turnover of US$1.15M, and largely broke even. However, this included US$0.5M losses on the straw/paper mill (which further demonstrated the business risks involved and prospects of mill closure in the near future). Decreased revenues to the year ending September 2008 resulted in net trading losses of US$0.79M. This is compared to profits of US$0.25M the previous year.

10.4 Key issues

A number of issues arise; most of which related to continuity of paper manufacture from straw and to the general viability of the Alexandria factory. Consider:

- **Viability of the RAKTA Alexandria factory** What options remain available for the factory to continue to manufacture paper in the Western Delta? The environmental issues of production have been highlighted over the years and discharge of toxic effluent into the Mediterranean Sea has become unacceptable. Markets for straw-derived paper are currently poor; the additional costs of adequate waste handling are not justified. The straw/paper line was closed in 2008.

- **Options for treating toxic waste** What options are available for further technical assistance to the Alexandria factory to assist management with treating industrial waste streams – with economically and environmentally accepted levels of investment? What domestic resources and/or expertise are/is available to assist?

- **National experience straw pulp** With more than 40 years experience of manufacture, there may be much to be gained by encouraging continuity of domestic paper production from rice straw (if markets permit). Can experience be captured and shifted to new locations/factories?

- **Relocation of paper manufacturing** Construction of cost-effective (and smaller-scale?) factories at strategic locations within straw producing/surplus areas of the Delta would help boost production/consumption of straw, reduce the impact of
environmental issues and, with new technologies/plant available, provide for employment, etc. in rural/small town areas.

- **Access to foreign technologies** To what extent is government/RAKTA interested in seeking external advisors, etc. to provide for expansion of paper making from rice straw? What commercial opportunities exist?
Chapter 11
Investment Choices

Summary

Adding value to agro-residues and gaining benefits of increased employment and wealth is a relatively easy-to-understand concept that will require a measure of planning, investment and political will. These resources already exist in Egypt from a host of national institutions, ministries and international partners. In reality there is no lack of investment funds, but more one of piecemeal development planning that has provided for confused decision-making across a spectrum of different environmental, production, economic development and politico-social priorities. The agricultural sector generates 13-20 percent of GDP and estimated 30 percent of exports (and provides 50 percent food security), but it remains mainly traditional in outlook and does not realise potential. Investment remains weak. Industry, transport, energy and similar sectors are easier to promote; and receive considerable investment interest. For an industrializing country with a rapidly growing population therein is a measure of contradiction; agricultural development requires access to the same level of promotion and inward investment as the remainder of the economy. Government will be obliged to develop the policies required to do so; and provide the incentives that will encourage the private sector to become more involved.

11.1 Achievements of the FAO/Government Egypt project

Much has been achieved by the FAO/GoE TCP project investment with raising awareness and highlighting opportunities for adding value to materials previously considered as ‘wastes’. Agro-residues have considerable potential as a means of meeting market requirements for a host of products, and can do this within systems that are environmentally benign, economically viable and socially valuable. Achievements can be summarized as publications (i.e. agro-residues workshop proceedings and technical manuals), more than 550 people trained, capacity building and networking. More can be done with sector development from 2009-on.

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31 Workshop proceedings. Papers and presentations from the final FAO/GoE TCP project workshop held November 2008 have been captured on CD, but no formal proceedings have been prepared. Similarly, the proceedings for the FAO/GoE TCP project ‘Agro-Residues’ workshop held May 2008 remain to be finalized.
Current achievements represent a logical starting point. They can be summarized as follows:

- **Capacity building - national project team** Good team rapport one-to-the-other with MALR/ARC leadership and individual R&D workers employed as National Consultants. People within the public sector have gained better understanding of ‘residues’ within rice production, the value of industrial approach to investment and opportunities for public-private partnerships.

- **Repository of information** Reporting from the FAO/GoE TCP project (including mission reports, end-of-assignment reports and workshop proceedings) has provided a useful overview of the domestic agro-residues sector. This technical manual provides a summary and review of findings – and will help focus investment during the following 5-10 years.

- **Industrial development** The ad hoc network of people established will be important for agro-industries development into the next 5-10 years. It includes those involved with technologies, products, agro-enterprises and employment – most of which offer potential for investment. Equally important are the entrepreneurs identified. Recognition of opportunity will follow as agricultural residues shift into markets for food, feed, energy and organic materials. A key issue will be one of promotion – and herein this technical manual can expect to make a useful contribution.

**Recommendations:** That further investment be encouraged - to follow findings from the FAO/GoE TCP project that continuity does not become lost; that the MALR/ARC continue to build upon the existing track record and achievements made, provide a repository of technical expertise and resources, and promote new opportunities for agro-residues investment; and that this be done with the technical assistance of FAO and UNIDO.

### 11.2 Straw-based products

An integrated market for straw-based products would ensure compatibility of supply and demand, with the security of supply required of the low-income producer *(for on-farm use)* matched to the demands of the industrial users *(for both novel and traditional markets)*. There is considerable flux within all markets notwithstanding the current value of
organic materials and maintenance feed for ruminants on the home farm. Off-farm use remains at best conjecture, with the limited industrial experience of small quantities of straw used for the manufacture of paper (i.e. of the order 150,000 t annually). Findings from the FAO/GoE TCP project have identified other factories with straw intake requirements (e.g. briquetting 500,000 t yr\(^{-1}\), gasification 11,000 t yr\(^{-1}\), and compost 360,000 t yr\(^{-1}\)). Cost-effective collection, storage and transport remain the basis for profitability. Elsewhere within the country, mainly R&D and university workers have explored chemical extractions, fertilizers, herbicides and other novel products from straw.

Notwithstanding the trends inherent in novelty and new ideas, there is merit in focusing on low-cost alternatives that are already well-known to local producers and manufacturers - livestock feed and organic materials. Herein are opportunities for more commercial ventures (of different scales) and for location in rice straw producing areas; and, it follows, that industrial investment of this kind has potential to create more employment and reasonable wealth in rural communities.

**Recommendations:** That investment in straw products is encouraged that benefit rural communities, make use of appropriate (manually-demanding) technologies, and manufacture products that are well-known and for which markets exist (e.g. for livestock feed, compost, etc.); that novelty continues to be investigated with the appropriate R&D programs and, equally, within existing investments for agency-led and public-private-partnerships-led ventures that have already established pilot-scale plant (e.g. for briquetting, gasification, etc.).

11.3 Agro-residues conceptual investment document

A conceptual design ‘*Agro-Residues Utilization*’ has been prepared for post-project investment; to encourage shared donor and local partner investment. This proposes investment of more than US$6M during a period of 4 years with objectives that will help better define national agro-residue resources, provide methodologies for conversion and help establish pilot-scale R&D plant and equipment. The project is described in Annex 3. Design can be changed as appropriate to meet the needs of the government, donors, investors and others.

11.4 Shared investment

There is currently no firm indication of post-project investment to provide a measure of continuity resulting from the recommendations of the
FAO/GoE TCP project. JICA has requested re-submission of a proposal made mid-2008. Further opportunities exist within AfDB investment proposed for agro-industries for 2009-on and within the Ministry of Environment supported Environmental Protection Fund (EPF). The investment proposal provides for greater clarity of priority investment opportunities.

Given the exploratory nature of the agro-residues industries proposed and the fragmented nature of resources, investment from the private sector is only likely to follow where public sector investment has shown a measure of success or where the greater proportion of risk will be taken by the public sector. A market-led strategic approach is likely to have more immediate success. There are numerous small- and medium-scale enterprises already exploiting rice straw; with potential for more to become involved.

**Recommendations:** That promotional effort should be undertaken within agro-industrial networks, domestic service providers and associated international agencies for support for some of the ideas, products, markets and investment opportunities for ‘agro-residues’ highlighted by the FAO/GoE TCP project - to attract more resources, people, funds, effort, interest, etc. into the industry/sector.

11.5 Partners in investment

The FAO/GoE TCP project has provided small resources to promote new ideas – and with a measure of success. The next period will require sector focus and more encouragement for the private sector to participate. Exploratory investment funds will be required. This will require partners. As at the time of completion of the FAO/GoE TCP project end-2008 a number of re-investment opportunities had been identified with a selection of partners. These included:

11.5.1 Partnerships with development agencies (*Further information in Annex 1*)

- **UNIDO** UNIDO will provide technical assistance – but no direct funding. UNIDO is a logical partner for pro-industrial investment for agro-residues into the next period. UNIDO has provided considerable goodwill and technical support for the FAO/GoE TCP project; and is willing to do more. The UNIDO ‘Agro-Enterprise’ workshop held in November 2008 highlighted the role of agro-business, etc. within national development priorities.
UNDP/GEF With more than US$16M available for investment in sustainable energy developments for rural communities during the next five years, there is much to be gained by those involved with, and/or processing and/or exploring, agro-residues by maintaining contact with UNDP and development partners. Estimated 90 percent of UNDP/GEF investment will be directed into agro-residues/energy conversion; and key markets will be rural communities with: (1.) Limited access to modern energy carriers; and (2.) Large amounts of crop residues available.

AfDB AfDB has proposals to channel investment into agro-industries development during the next 2-5 years. Effort should be made to ensure that all agro-industrialists, business people, entrepreneurs and similar are kept abreast of funding opportunities that may be provided. Investment is likely to be mainly community-based. Exploratory AfDB missions will be fielded from early-2009 on.

DANIDA DANIDA has left a national legacy from work completed in 2008 with the establishment of the US$63M Environmental Protection Fund (EPF). EPF Funding is available to all - and for all kinds of applied investments including selected agro-industrial ventures with socio-economic potential and environmental sustainability. The annual DANIDA-supported ‘Environment Report’ is recommended reading for all investing in the sector.

JICA A draft investment proposal was prepared and submitted to JICA for investment funding (with which to continue some of the agro-industrial opportunities highlighted by the FAO/GoE TCP project team). The proposal submitted mid-2008 was further re-developed and submitted for early 2009 at the request of JICA.

World Bank With more than US$1.4B invested in the country and more than 50 percent in agriculture, environment, education and infrastructure development, opportunities for linking the outcome of the FAO/GoE TCP project with the work of the Bank are obvious – but need to be better defined.
Investments from others

There are extensive resources of funds and expertise available for national development priorities – from within national and international communities. External assistance is of the order US$2B each year. Most of this is invested in people-orientated programs which, in more recent times, have focused upon attainment of the Millennium Development Goals. Implicit and de facto, however, many of these are carry-over investments that continue to support environmental sustainability, more efficient resource utilization and social stability. Agricultural development takes a leading role.

11.5.2 Partnerships with Government

Numerous partnerships opportunities are available of which many have linked directly to the FAO/GoE TCP project. Consider:

Ministry of Agriculture and Land Reclamation

The Ministry is responsible for national policy in agriculture, land reclamation, water development and agricultural productivity that provides for the socio-economic welfare of rural communities; and coordinates these policies into plans that provide for the security and development of the nation state. Three MALR technical institutes have linked directly to the FAO/GoE TCP project (further information contained in Annex 2)

- Field Crops Research Institute (FCRI) Host/national counterparts to the FAO/GoE TCP project, the FCRI has provided technical assistance, facilities, advice and leadership courtesy of the team of experts based at the ARC, Giza and the RR&TC Sakha, Kafr El-Sheik.

- Soil, Water & Environment Research Institute (SWERI) SWERI has a mandate to promote, explore and generally encourage an appreciation of the value of soil nutrients in agriculture; and composting and biogas production technologies as a means of achieving higher productivity.

- Agricultural Engineering Research Institute (AERI). AERI is responsible for national leadership for mechanization, post-harvest

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technologies, agro-industries, biotechnologies, land and water engineering, plant production and protection, farming systems and agro-meteorology.

**Ministry of Environment**\(^{33}\) The majority donor-funded initiatives linked to straw utilization, etc. have come courtesy of the Ministry of Environment (2009). Funding from the Environmental Protection Fund is potentially available to everyone – public and private sector people – in support of pro-people and pro-environment investment. Of the order US$63M is available; at an annual disbursement of US$5M-US$7M. Exploratory effort will be required to determine opportunities for the establishment of appropriate agro-residues enterprises, purchase of equipment, training, credit, etc. Given the importance of the Ministry of Environment within agency-led investment in Egypt, there is much to be gained by those working in support of agricultural industries (production and post-production) with developing closer working relationships with the Ministry of Environment.

**Ministry of Trade & Industry**\(^{34}\) Provides national services that link investors with manufacturers and traders. It has responsibility for state policy that encourages the expansion of industrial development and the sustainable exploitation of national resources. Of particular interest to the FAO/GoE TCP project has been the activities, etc. of the Industrial Development Agency (IDA) of the MFTI. Herein are policies that promote investment, ensure quality, provide incentives, information and infrastructure, and channel national effort. Focus orientation is more large- and medium-scale.

**Ministry of Investment**\(^{35}\) Supports government’s mandate to implement reform program aimed at boosting investment across the economic spectrum; coordinates between institutions, companies and ministries and manages all public sector assets. Responsible for encouraging inward investment from both domestic and foreign sources. Of particular interest is the ‘Egyptian Investment Portal’ providing a shop-window on investment opportunities including ‘Agriculture’. Currently promoting production of sugar beet (with US$114M required over three years and proposed output 125,000 t from more than 1,600 ha near to Alexandria). Solid waste recycling opportunities also listed.

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Ministry of Economic Development\textsuperscript{36} Lead ministry of national planning. Provides repository of economic and socio-political indicators; prepares national accounts, national poverty report, human development report and progress reports for attainment of MDGs. Responsible for compilation and management of rolling 5-year development plans. Currently partway into the sixth 5-year plan. Current 5-year plan is essential reading for all engaged in agro-industrial development (and, particularly, sector development for ‘Agriculture’, ‘Industries’, ‘Energy’, ‘Transport’, etc.). Provides framework in which agro-residues industries will receive sufficient attention to warrant investment.

Social Fund for Development (SFD) Autonomous government institution with mandate to ameliorate the many issues that impact upon low-income people. SFD has objectives that ensure government policies will help alleviate poverty, provide adequate safety nets and generally help poor people to help themselves. SFD provides funding for SMEs (and similar socio-economic investment).

11.5.3 Public-private partnerships

Public-private partnerships (PPPs) are being widely promoted nationally and, particularly, as a means of partially shifting state-owned enterprises into commercial ownership. Partnerships of this kind help access the skills, expertise and financial resources of the business community; and further foster competitiveness. Herein may be new opportunities for finding innovative and pragmatic solutions to some of the many complex issues facing national development.

Recommendations: That the FAO/GoE national team (at the MALR/ARC) continues to explore opportunities, from networks of collaborators and make application to sources of funding that will provide for continuity of investment - this will require considerable pro-active effort; that this would be best achieved within the resources of another project initiative; that a start be made with the international partnerships identified (and listed above); that more use is made of inter-ministry networks that can be developed.

\textsuperscript{36} Ministry of Economic Development Further information available at: www.mop.gov.eg/English/english.html.
11.6 Challenges for government

Notwithstanding the many opportunities identified for increasing the use of rice straw (and other agro-residues), the extent to which this will develop will depend largely upon the promotional activities of the government and the conducive policies and incentives provided. The findings of the FAO/GoE TCP project exemplified the stratified nature of the public sector; with little in the way of coordination and shared interests. Separate parallel investments are underway with little or no reference to the relatively small resource base available; raising issues for the competitive nature of the different markets that may arise (exploiting feed, food, energy or nutrients from residues). A useful start could be made by accurately confirming the quantities of materials available each year. Without reliable information of this kind, the development of a strategy for straw utilization (and investments that may follow) remains open to conjecture and estimation, which is not acceptable to investors. Further, government has the potential to stimulate investment with a host of different incentives including tax breaks, land concessions, export subsidies and similar. Incentives of this kind reduce risk, and invite novelty and competition. Further information to describe opportunities for government are described by da Silva (2007).

11.7 Lending Institutions

Micro-lending is required for all small and micro-enterprise (SME) investment. Micro-financial services are available from (1.) Banks; (2.) NGOs (normally under the control of the Ministry of Insurance & Social Affairs37); and (3.) Social Fund for Development (SFD). The principal banks include the National Bank for Development, Banque du Caire and the Principal Bank for Development & Agricultural Credit. Conditions for loans vary with interest rates of up to 13 percent, terms of up to five years and loans within the range US$35-US$1,800. NGOs typically work in partnership with donor organizations.

11.8 Economic reconstruction

Government of Egypt and development partners are making considerable efforts with economic reconstruction. In recent times, this has

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37 Ministry of Insurance & Social Affairs. Since compiling the manual, this ministry has been split into two parts. Insurance has been integrated into the Ministry of Finance and Social Affairs has been combined with the Ministry of Supplies to form the new Ministry of Social Solidarity.
resulted in reduction of national subsidies for fertilizers, energy, fuels and similar. The trickle-down effect on-farm will be higher production costs and, importantly, higher value for materials/resources that were previously considered low-value (and frequently wasted). Low-cost straw from rice may no longer be available into the next period; and this will have ramifications for access to low-cost feed for ruminants, compost and similar traditional products. Change is likely to be rapid and more so as larger quantities of straw are purchased for industrial processing. The participation of international donors within economic reconstruction programs has been described by ESIS (2009a).

11.9 Egypt and global financial crisis

Investment follows confidence in market opportunities allied to a benign climate in which investors are better able to protect their investments. Encouraging investment into ‘Agro-Residues’ development cannot be considered in isolation to current international issues of financial downturn. Notwithstanding strong links to the US economy from long-term mutual self-interest, the primary factors that have adversely affected most western trading nations (such as mortgage debts, bank default and the collapse of major insurance and other financial institutions) have not directly and significantly impacted on the Egyptian economy. The country is reported as having banks that are not burdened with a large proportion of debt (with less than three percent mortgage debts) (ESIS, 2009b), with a fairly robust economy and with a healthy inward investment program led mainly by the Arab States (ESIS, 2009c).

11.10 End note – taking action

Egypt has a robust network of international investors working in support of socio-economic development and quasi-commercial investment linked, respectively, to the main western trading blocs and to the Arab/Gulf States. Herein is the basis for investment into the next period and notwithstanding on-going issues that relate to increased population growth, static (and/or diminishing) natural resource base and, crucially, rising expectations on the part of the majority people. Agricultural productivity within the many complex challenges that will prevail during the next 10-20 years remains a constant aim – producing ever more crops, livestock and other goods from land, water and people that are already under pressure to produce more. Changes projected for national and regional climates during the next 50 years are likely to raise these issues further (and particularly should current agreements on the use of the resources of the River Nile fail
to meet expectations of all national signatories). The role of ‘agro-residues’ utilization within the priorities that will prevail are relatively easy to foresee – with a ‘win-win’ situation for both rural and urban dwellers; shifting material currently wasted into traditional products (e.g. feed, organic nutrients, new lands, etc.) and new products (e.g. energy supplies, chemicals, etc.) and reaping the benefits of increased employment and more wealth for the people involved.

Agro-residues utilization is an easy step into more efficient and cost-effective agro-industrial production that will be essential during the next 5-10 years as the country shifts agricultural productivity from current baselines into the value-addition required of higher incomes. The challenge to the nation is one of making logical and easy-to-understand decisions and then to marshal the investments required to make them reality. This will be essential.
References cited and further reading recommended


UNDP. 2006b. ‘*UNDAF: Moving in the Spirit of the Millennium Declaration – the DNA of Progress*’. Paper. UNDP, Cairo, Egypt.


Annex 1. Activities of international development partners

A1.1 United Nations Industrial Development Organization (UNIDO)

Summary

There have been many similarities within the work of UNIDO and FAO in recent times as exemplified by the respective technical programmes shared with the Government of Egypt. The FAO/GoE TCP project has been a case in point, with UNIDO actively involved with qualification of some of the information provided. There is scope for building on the respective track records and strengths for the cost-effectiveness and synergy that may develop. This will be particularly valuable for agro-industrial investment into next period, for example, for the development of foods and bio-fuels industries that need to meet international norms and standards for regional trade and/or domestic utilization. The two agencies are complementary within their respective technical sectors but issues of duplication are likely to occur, for example, with the further development of industries based on agro-residues. Any future investment proposals should be shared between the two agencies and their respective national partners.

Program of work in Egypt

Of particular interest to project TCP/EGY/3102 has been working underway by UNIDO to promote sustainable energy resources and energy conservation, cleaner production technologies, traceability of agro-industrial products and the provision of technical assistance to the RAKTA paper/fibers processing factory in Alexandria (for control of ‘black liquor’ effluent) and for the replacement of methyl bromide as horticultural fumigant. The program has, in recent years, led to the establishment of the Egypt National Clean Production Center (ENCPC), the Egyptian Traceability Center for Agro-Industrial Exports (ETRACE), the Investment Promotion Unit (IPU) and, during the next period, may result in the establishment of a national bio-energy center (ENBEC).

Issues/opportunities to consider

Shared FAO/UNIDO effort/investment into the next period is logical given the considerable overlap that exists and the synergy that can be developed within the current UNIDO/GoE program and the outputs of the
FAO/GoE TCP project. In several sectors, the two agencies are already working in parallel (if not in de facto competition). Consider, for example:

1. Bio-Energy Center (ENBEC) Two recent UNIDO reports directly link to the exploitation of agro-residues in Egypt, viz. (1.) ‘Establishment of a National Bio-Energy Center’ (Megeed, 2008); and (2.) ‘Lignocellulosic Biomass Conversion Technologies for Bio-fuels Production’ (FM Aly and Megeed, 2008).\(^{38}\) The ENBEC proposes to link on-going bio-energy R&D/exploratory activities in the country into an established network structure and to provide national facilities (i.e. the ‘Center’) for dedicated and promotional activities that cannot be undertaken elsewhere. Design will encompass four separate units (i.e. biomass processing, applied science, bio-refinery and pilot-scale processing). Funding will come from a mix of national and international sources. A time-line for investment of 10-years has been proposed. Some reporting suggests that the bioenergy center has already been established, but neither UNIDO nor others in the FAO/GoE project team were confident that an actual ‘Center’ exists (as in December 2008). It may be that this is being discussed in ‘conceptual terms’ as a means of encouraging investment from the appropriate partners. In 2008, however, Egypt and partners (i.e. GTZ, EU & DANIDA) had already established a ‘Renewable Energy Promotion Center’ at Nasser City with focus upon wind and solar energy (McDermott, 2008). Issues of infrastructure, storage and transmission losses are described (with more than 25 percent power generated normally lost in transmission).

2. Current UNIDO activities With few exceptions, all current work underway within the UNIDO/GoE programme is of value to FAO/GoE agro-residues project activities. This includes work shared with the Ministry of Investment and Ministry of Environment,\(^{39}\) chemical leasing, recycling organic wastes, targeting MDGs (with access to

\(^{38}\) \textit{Agro-residues production}. High standard reporting by FM Aly & Megeed (2008) suggested agro-residues production of more than 25M t of which 15 percent is rice-based. The ENBEC proposes a ‘regional center’ at Mansura in the Delta with focus on rice straw utilization which, if it becomes reality, could link to the work of the MALR/RR&TC rice production team at Kafr El-Sheikh.

\(^{39}\) \textit{Ministry of Environment}. UNIDO has been working closely with the Ministry of Environment in recent times. Topics covered have included rice straw evaluation and utilization, and the production of bio-fuels.
funding from the Government of Spain), agro-industrial goods for EU markets and bio-fuels. Shared training activities are logical (e.g. UNIDO workshop of March 2008 focused upon the sustainable production of plastics from agro-industrial wastes). UNIDO representatives also attended the FAO/GoE project ‘Agro-Residues’ workshop May 2008.

3. **Agro-Business Workshop** UNIDO hosted a successful agro-business workshop in Cairo, 26-27 November 2008 entitled ‘From Farm to Markets’.[40] Delegates including those from FAO debated some of the more fundamental issues of local production and identified constraints faced by many agro-producers/business people. This included unacceptably high levels of crop loss between harvest and markets (suggested at more than 70 percent), the role of technical assistance (for access to technologies and business/financial acumen) and the need for financial support.[41]

4. **Equity funding** UNIDO has recommended that a start be made with the establishment of an ‘AgriFund’ that would, with competent management, become a private equity fund within 8-10 years. Similarly, high levels of post-harvest loss, if substantiated, are unacceptable and investment with use of equity funding should be redirected into effort, infrastructure and technologies to reduce losses.[42]

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[40] Agro-Business workshop. More information to describe the workshop, debate, delegates, etc. and outcome will eventually be available at: [http://www.agribusiness_solutions.org](http://www.agribusiness_solutions.org).

[41] Post-harvest food losses Egypt. Losses of more than 70 percent are high and particularly so for an industrializing country. Badawi (2004) suggests losses typically 10-37 percent (and mainly transport based).

[42] FAO Post-Harvest Loss Program (PFL). FAO has considerable experience of the sector. Implemented during a 20-year period from the mid-1970s on, the FAO/PFL program was instrumental in boosting agricultural production across Sub-Saharan Africa, South & SE Asia and Latin America. More than 250 PFL projects were implemented in more than 45 countries. This resulted in a repository of technical, socio-economic and financial information much of which remains available; and much of which can be sourced courtesy of a shared FAO/GTZ/CIRAD website. This is available at: [http://www.fao.org/inpho](http://www.fao.org/inpho). A second post-harvest site worth exploring is available at: [http://www.foodnet.cgiar.org/PhAction/strategy.htm](http://www.foodnet.cgiar.org/PhAction/strategy.htm).
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A1.2 United Nations Development Program (UNDP)

Summary

UNDP is the lead UN agency in the country and typically coordinates the separate UN development programs within a ‘UN development assistance framework (UNDAF)’ that meets the aspirations of the country. The current UNDAF represents the mid-point of a five-year period due for completion by 2011. The previous 5-year period delivered more than US$177M into sectors in support of ‘human development’. For FAO/GoE agro-residues exploitation the key sectors include ‘energy/environment’ and ‘poverty reduction’ (as it links into employment creation). Herein are separate investments in support of agro-industrial developments that will exploit alternative energy resources into the next period. The UNDP/GEF ‘Sustainable/Energy’ project with funding of more than US$16M represents the most significant investment underway.

Program of work in Egypt

All UN agencies working in Egypt currently subscribe to the UNDAF for the period 2007-2011. The UNDAF aims to assist the state with meeting obligations that will fulfil the social, economic and political norms of its citizens (i.e. to provide good governance). ‘State’ in this respect is government, civil society, private sector, etc. (and not simply the GoE). UNDP has adopted a twin-track approach that will: (1.) Provide socio-

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43 UNDAF. Five separate priority areas are targeted for achievement by 2011, viz. boost in state performance, higher employment, improved human development, enhanced role for women/development and better human rights (UNDP, 2006b). Much of the UNDAF paper has been based on the UNDP report ‘Arab Human Development’ from 2002.
techno-investment that will boost the quality of life of people; and (2.) Encourage the state to realize the MDGs, establish laws, protect citizens, etc. The current 5-year UNDP program of work is described in a 10-page document with supporting log frame (UNDP, 2006a). Lessons learned from the two previous 5-year plans have made significant progress with core civic contributions (i.e. human poverty, democratic governance & energy/environment) with the current five year plan leading from the US$177M investment of the previous cycle. Investment of US$39M in 2005 represented the highest UNDP delivery ever for a single year.

**BioEnergy and Sustainable Rural Development**

Notwithstanding shared agency development over many years (in Egypt and elsewhere) the highlight of current UNDP activities within the sector is represented by the independently UNDP-managed and part GEF-funded initiative ‘BioEnergy for Sustainable Rural Development’. This represents more than US$16M investment over a period of 5 years beginning 2009 for the promotion of sustainable rural development on the basis of a range of renewable energy technologies. GEF have provided more than 50 percent of total budget including US$3M as grant funds. Focal area will be ‘Climate Change’.

The modus operandi is likely to build upon national repositories of existing R&D innovation and quasi-commercial technologies that will aspire to cover all renewable energy technologies (and particularly where a measure of overlap exists), but the reality is one where more than 90 percent of investment is likely to be directed into biomass recycling for heat energy. This will represent all rural biomass resources (including agricultural-, municipal- and sewage-based). A programme of activities will link surveys and analysis of resources and demand to inventories of options, opportunities, experience and potential and, subsequently, into strategies for market exploitation (of the different technologies, outputs, industries, employment, wealth creation, etc.) that will suit rural communities. The project will be executed by the Egyptian Environmental Affairs Agency (EEAA) of the Ministry of Environment.

Much of development will focus upon existing R&D innovation and expansion of technologies and ideas that appear to have merit and for which markets can be exploited. The project thus becomes one of resource management – highlighting, promoting and investing in known experience/technologies where a measure of success is likely. Given the logic of project design, the wonder is that a project of this kind has not previously been implemented.
The UNDP/GEF project document is of value to those investing in agro-residues industries for the analysis provided within the different energy technologies and markets that exist (GEF, 2009). The national energy background is explored in the context of opportunities for the extent of the agro-industrial potential described. Much of this would have been of value to the work of the FAO/GoE TCP project (had it been known earlier), but it will continue to be of value into the next period of agro-residues exploitation. Given that the UNDP/GEF project has been more than 6 years in preparation, herein is reflection on the apparent lack of shared information between the respective national groups and international agencies with information of this kind.

**Issues/opportunities to consider**

The current UNDP/GoE program provides a number of opportunities for boosting shared investment. Consider:

1. **UNDP/GEF project 'BioEnergy & Sustainable Development'** UNDAF for the period 2007-2011 has objectives of ‘sustainability’ within which the UNDP/GEF project with more than US$16M (with GEF investment representing more than 50 percent budget) is likely to dominate for the five year period from 2009-on. The project document is required reading for everyone interested or investing in the sector. As appropriate, all FAO/GoE post-TCP project investments in agro-residues as a source of energy should refer to the program of activities proposed for the UNDP/GEF project.

2. **Shared UN/agency ventures** The UNDP Representative recommended that the FAO/GoE TCP project team make effort to ensure that they remain aware of any appropriate ventures that may comply with the respective objectives of the two agencies (including MDGs, employment creation, etc.). This is logical given that both agencies subscribe to a common UNDAF for the current period (and to GoE national development priorities), but this will require that effort is made to share information, etc. during conceptual/planning stages. Current findings suggest that limited exchange is made.

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**A1.3 African Development Bank (AfDB)**

**Summary**

A long-term member country of the AfDB, Egypt holds a key geo-socio-economic position in North Africa, the Middle East and within the Arab countries. It is the leading industrializing country in NE Africa with considerable potential for providing leadership to others with south-south/TA ventures. As a middle-income country Bank investments have been limited to loan funding (with small grant funds available) totalling of the order seven percent of all AfDB regional disbursements during more than 40-years. Opportunities exist for the MALR/ARC team to exploit the information/investment potential of the AfDB Finesse Energy Services Program. This is recommended. Similarly, proposals for boosting AfDB-funded agro-industrial investment during the period 2009-2010 should be monitored.

**Program of work in Egypt**

The Bank has four principal functions, viz.: (1.) Loans & equity investment for regional members; (2.) Provide TA in support of investments; (3) Promote regional investment; and (4) Coordination in support of regional initiatives. Funding is provided from three sources, viz.: (1.) African Development Fund (ADF); (2.) Nigeria Trust Fund (NTF); and (3.) AfDB. ADF & NTF funds are available for the poorest countries; and AfDB funds to the middle-income countries. Egypt, for example, has been a beneficiary of AfDB funds.

*Building today for a better Africa tomorrow* features on much of AfDB literature; and in Egypt has reflected in the disbursement of more than US$3.7B in 50 interventions over more than 30 years. The country currently has disbursement of more than US$670M available. Significant on-going investments include power generation and support for SMEs. The Bank recently provided loans of US$500M for structural/financial reforms – the largest ever made to a regional country. Lines of credit and TA valued at US$288M have been provided in recent times for SMEs of which 30 percent was allocated to the Social Fund for Development (and targeting 110,000 new jobs expected by 2017). Ultimately, all AfDB investment in the country is linked to the creation of stability in communities.
Issues/opportunities to consider

AfDB development opportunities link to both agriculture and energy. Consider:

1. **AfDB Finesse Africa Program** Linking energy and the well-being of people within national economies; with objectives that seek to boost energy-efficiency, sustainable energy alternatives and higher energy consumption in Africa. Sector focuses on both petrochemical/electricity and alternatives, with objectives that aim to reduce poverty, boost living standards, etc. (and link further to improved water supplies, clean air, sanitation, etc.). Herein are opportunities for the MALR/ARC team to seek more information and investment funds that comply with the ‘Clean Energy Investment Framework’ that finances energy services for small-scale energy users. The AfDB Representative recommended that the FAO/GoE TCP project team should explore this route. A starting point would be to subscribe to the ‘AfDB Finesse Africa Newsletter’.

2. **Regional integration** Egypt has a leading role within NEPAD and has integration arrangements with a host of African national groups (e.g. Maghreb, Nile Basin, COMESA, AU, etc.). As the leading industrializing country in the region, much can be done within south-south initiatives. Harmony, for example, with the common use of the Nile waters is essential. The ARC, for example, has strong links into counterpart organizations in Sudan for food production. FAO is also ‘regionalizing’ with a newly established sub-regional office in Addis Ababa.

3. **Industrialization-led investment** Making more use of under-utilized industrial resources (and particularly in the public sector) with associated human skills training, upgrading technologies, education, etc. FAO and the MALR/ARC have potential for additional partnership arrangements (with agro-residues use, etc. but also within a wider rural development context) during the next 10-years.

4. **National self-sufficiency in Egypt** Changes with government priorities during the year for boosting national self-sufficiency in a host of sectors (such as food production, energy efficiency, employment creation, etc.) as a reflection of prevailing international and domestic issues has been reflected in a portfolio of national investment proposals developed by the AfDB for the next period. This will include efforts to
stimulate agro-industrial investment. The Bank considers FAO as logical partner within the sector. Follow-on from the existing FAO/GoE TCP project will provide scope for exploratory investigations. This will need to be encouraged.

5. **Agro-Industrial investment** AfDB plans an initiative during 2009/2010 to boost agro-industries (and particularly food industries) investment in Egypt, and recommended that the MALR/ARC project team (with their links to FAO) remain in direct contact with the Bank and its proposed investment programs. With identification missions scheduled for February-March 2009 leading to selected industrial investment missions for end-2009 and financing due for 2010, the FAO/GoE TCP project team will be well placed to participate and/or share in new opportunities – briefing and debriefing missions, participating in missions and/or directing industrial sector development. This will enable them to provide focus on sector interests, for example ‘rice and residues’.

6. **Grant funding selected investors** Egypt does not normally qualify for grant funding given ‘middle income’ development status within the AfDB, but current proposals include finance for small-grant funding to industrialists, communities and/or sectors that may qualify.

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A1.4 Ministry of Foreign Affairs Denmark/DANIDA

Summary

The DANIDA-led development program in Egypt was completed end-2008. During the period of tenure it was based upon public-private sector partnerships for a host of agricultural, industrial, energy and environmental investments. A wide-ranging portfolio of activities was supported for many years, but remained little known to the FAO/GoE TCP project. The MALR/ARC project team has been recommended to follow-through with seeking more information and making contacts within DANIDA/GoE-linked networks that will continue to function post-DANIDA investment. Investment funds available from the EPF should be explored.

Program of work in Egypt

Notwithstanding firm socio-economic approach to international investment, much of the shared DANIDA/GoE programme has focused upon technical assistance, provision of infrastructure and trading. Herein have been discrete investments in agriculture and energy.

Energy-related investments have explored domestic petrochemical industries. Wind as a resource has been assessed and exploited. Loan funds provided by Denmark (and other EU countries) has resulted in joint Danish-Egyptian manufacture of wind turbines and the construction of wind farms on the Red Sea with power output estimated at more than 540 MW by 2008. This pre-dates the development of a national wind energy industry into the next period.

The work of DANIDA and the Ministry of Environment was first introduced to the FAO/GoE TCP project in April 2008. A summary of this work was eventually presented to the MALR/ARC ‘Agro-Residues’ workshop in May 2008.\footnote{DANIDA Environmental Project. The paper presented to the workshop by the DANIDA National Coordinator described the institutional support provided to selected governorates in the country for investment in a host of programs and activities that will ultimately lead to a boost in environmental care. This included awareness raising (at different administrative levels of national government), capacity building, environmental planning, introduction of appropriate technologies (for waste control, management, pollution reduction, etc.) purchase of equipment, etc. Some focus had been given to reduction of rice straw burning with planning for the strategic location of straw recycling factories in the Nile Delta. An aerial pollution control management center has been established with a measure of coordination between relevant departments and ministries. See Mournir (2008).} During the next 5 years the DANIDO legacy will
remain in the form of the Environmental Sector Programme (ESP), which is expected to provide of the order US$63M within an Environmental Protection Fund (EPF). Funding is available to all; and for all kinds of investments including selected agro-industrial ventures with socio-economic potential and environmental sustainability. Grant funding is expected to cover a period of minimum five years starting with disbursement of the order US$5M-7M annually.

During the past four years the Ministry of Environment/DANIDA have been instrumental in preparing and publishing the annual ‘Egypt State of the Environment Report’, which provides a useful overview of the ‘Environmental State of the Nation’. The report explores issues of air, water and land within the context of the urban environment and national development priorities. This includes a section on agricultural waste management. The 2007 Arabic language edition was published in December 2008; with the English language edition due in January 2009. There was a measure of critique that the report did not establish and/or set targets within the different sectors.

The FAO/GoE TCP project met with representatives of the DANIDA/GoE environmental program as part of the combined investment effort to link business with the reality of environmental compliance and good practices. Herein are agro-residues and city waste opportunities that can be developed into alternative energy industries, with information already available to qualify industrial investment and, importantly, a friendly donor agency with a proven track record of success. Further, herein are the many-faceted investments required of food, agriculture, environment and energy into the next 5-10 years. All link to rural communities.

**Issues/opportunities to consider**

Linked to Danish-promoted business development opportunities and the agricultural resources of rural communities. Consider:

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45 Environmental Protection Fund. The EPF is expected to become independent of, and managed separately from, the Ministry Environment in early 2009.

46 Environmental report. Available at: [http://www.eeaa.gov.eg](http://www.eeaa.gov.eg). Also available in hard copy from the Egyptian Environmental Affairs Agency, PO Box 11728, Cairo, Egypt.

47 Environmental investments. Linkages between the success of environmental/energy programs in Denmark with leading international companies establishing as the result of the national R&D programs during the period 1970s-on have potential for adoption/adaptation for Egypt. The DANIDA-supported ‘Business-2-Business Programme (B2B)’, Environmental Compliance Office (ECO)’ and the ‘Environmental Sector Programme (ESP)’ exemplify the extent of the networks that can be exploited with public-private partnerships (PPP). Additional information is available at: [http://www.ambkairo.um.de/en/servicemenu/News/](http://www.ambkairo.um.de/en/servicemenu/News/)

2. Agro-wastes management The DANIDA Coordinator at the Ministry of Environment has extensive local knowledge and networks for the collection, utilization, etc. of city, industrial and agricultural wastes/residues (across the industry). Opportunities exist for shared visits that the MALR/ARC project team can seek more information. Equally important, is introduction to the Environmental Protection Fund (EPF)/Projects Department, and access to resources available for co-funding small-scale investments. Potential investors are recommended to visit the Ministry of Environment website and follow the project application methods shown.

3. Networks The eco-technical networks that impact upon the Ministry of Environment (as exemplified by DANIDA investments) are extensive; and far superior to those known to the MALR/ARC project team. Herein is GoE investment (i.e. from Ministry of Environment & Ministry of Trade & Industry) that has largely by-passed the MALR with market-led opportunities. The current DANIDA project was completed end-2008. Networks should be explored further before people and groups have become dispersed.

4. EPF investment funding Given issues of aerial pollution arising from the disposal of rice residues by burning, the MALR/ARC project team are recommended to explore the EPF to qualify conditions under which funding may be provided. There is every advantage to be gained from support within existing work programs or within rice producing communities with which they normally work.

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A1.5 Japanese International Cooperation Agency (JICA)

Summary

Japanese International Cooperation Agency (JICA) represents one of the major international donor agencies, and has been investing in Egypt for more than 30 years. Investments have covered five specific fields of cooperation – two of which linked to the activities of the FAO/GoE TCP project, i.e. ‘rural development’ and ‘global environment’. Investment opportunities may arise for post-TCP project investment in agro-residues utilization in Egypt courtesy of an invitation made by JICA to submit a proposal for funding. A concept note containing an appropriate project design was sent to the JICA Representative Cairo in July 2008 and later revised and re-submitted in January 2009. If approved, implementation of a study appraisal is practical from end-2009 on. A visit of the FAO/GoE TCP project Team Leader to Japan in early 2008 had also raised issues for investment in a bio-fuels plant based on agro-residues from rice, although this is no longer being considered.

Program of work in Egypt

Recognizing the pivotal role of Egypt within the Middle East and North Africa as a stabilizing influence within the socio-political economies of the region, JICA has recently implemented a new ‘Assistance Programme’ within the country. Targets are: (1.) Sustainable economic growth & employment; (2.) Poverty reduction and boosted living standards; and (3.) Regional stabilization. Growth has reflected in investment in infrastructure, water and transport networks (in mainly urban areas) and the
promotion of trade. Stability has linked to the provision of Egyptian experts for neighboring countries, for example, in medicine, power, technologies and similar.

Agricultural investments have featured over recent years within the ‘Rural Development’ sector (for example, for water resources, irrigation, rural development, cold storage and mechanization). Much of this has been grant aid and much of it has now ceased. Similar work in support of the ‘Economic Development’ sector (such as steel mills, power stations, etc.) has also ceased. Work continues within the ‘Global Environment’ sector (with focus, for example, on the water resources of the Nile Delta, urban water in Cairo, etc.). There has been a shift to grant aid and/or third country training.

**Issues/opportunities to consider**

Notwithstanding the diversity of current programs shared between JICA/GoE, three key issues arise for follow-on for the FAO/GoE TCP project, viz:

- **Mission Team Leader Japan 2008** Visit of the project Team Leader to Japan (to receive an award for ‘services to agriculture’) and discussions held for the use of rice straw for bio-fuels production.

- **JICA request proposal investment** Submission made by the project Team Leader to JICA to consider post-project investment in sub-sectors that will reflect national need and comply with the transfer of Japanese technologies, skills, information, etc. to Egypt. Concept note submitted mid-2008, reviewed and resubmitted a second time early-2009. Concept note complies with proposals are described in Annex 3.

- **Bio-fuels industries study Egypt** Completed October 2007 by the Japan Development Institute and based on the exploitation of jatropha/BDF in five areas of the country.\(^{48}\)

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\(^{48}\) **Bio-fuels Development.** Notwithstanding current R&D level interest in rice straw/ethanol, JICA is promoting the advantage of jatropha/biodiesel fuels (BDF) production given the productivity of jatropha (*Jatropha curcas*) in Egypt (and quote yields of 1.2 t ha\(^{-1}\) from well-managed plantations; 1,300 trees ha\(^{-1}\) and 4 kg seeds tree\(^{-1}\); and 23 percent conversion BDF – 25 percent crude oil extraction and 90 percent BDF). Moreover, there are buoyant markets for BDF in Europe, and producing bio-fuels from non-food crops neatly steps around politico-moral issues of bio-fuels production from food crops. GoE are promoting a national industry with projections for 400,000ha, 1.2 Mt and 1.5M jobs to be created. Earnings of US$1.2B have been proposed for 2020.
These link one-with-the-other for provision of post-project investment that would enable the MALR/ARC to explore, for example, technical innovation that would comply with current national priorities of environmental sustainability, agricultural productivity and social equality. JICA suggested an investment route that would begin with ‘Development Study’ investment of value US$2M linked to subsequent ‘Grant Aid’ and/or ‘Technical Assistance’.

JICA provided the FAO/GoE TCP project with copies of the ‘Development Study Programme’ application papers required and with an example copy of an earlier submission. JICA invests government to government, and a proposal of this kind would have no role for an international agency for provision of TA, administration, execution, etc. Notwithstanding issues of this kind, JICA support would provide for post-project development. This is recommended. The key issue will be one of preparing a proposal/concept of appropriate design that would meet investment priorities and the submission deadlines of both countries; and following it through the various stages involved.

JICA remained neutral for the priority of the re-submission and suggested that the MALR/ARC Team Leader make a second submission to meet a mid-term application date (i.e. for 30 March 2009). It may be that the second submission will come within new methods of scrutiny and/or appraisal of project investments. JICA emphasized the importance of deleting all R&D technologies from any new proposal (including reference to bio-fuels/ethanol production from rice straw); only well-proven technologies will receive support.

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A1.6 World Bank

Summary

With more than US$1.4B invested in the country of which more than 50 percent is linked into agriculture, environment, education, health, and infrastructure development, opportunities for linking the outcome of the FAO/GoE TCP project with the work of the Bank were obvious. The reality, however, is one in which neither meetings were held between
representatives nor any real exchange of information, etc. took place. There were simply insufficient resources of people and time available. This should not, however, detract from future opportunities for exchange.

Program of work in Egypt

For mid-2008 the Bank/GoE portfolio of investments have included 15 projects in agriculture, infrastructure, social protection and the environment. Development partnerships have been established with the government and NGOs; and with additional decision-makers drawn from the universities, parliament and the private sector. Stakeholders from civil society are taking an increasing role with investment from the Bank, as reflected in the Small Grants Program, Development Marketplace and the MNA Parliamentary Network.

Agriculture remains a high priority sector together with water conservation and use, and boosted productivity for landholders. Typical cross-sector investments have included West Delta Rehabilitation (US$145M), East Delta New lands (US$15M) and Integrated Irrigation (US$120M). Socio-infrastructural investments have included structures US$385M (e.g. Cairo airport and drainage), power US$335M (e.g. gas connections and electricity generation) and education and health US$305M. The environment (and associated infrastructure) has also been important with more than US$300M invested (e.g. sewage and industrial pollution). The latter has enabled Egypt to undertake projects that complied with the Clean Development Mechanism (CDM), and gain access to carbon finance. A recent overview of the work of the Bank in Egypt is available at World Bank (2005).

Issues/opportunities to consider

There were few opportunities for meetings with Bank representatives during the tenure of the FAO/GoE TCP project, but e-mail correspondence and telephone discussions were practical. There were no immediate opportunities/issues of relevance noted except that of recognizing potential.

1. Outcome FAO/GoE TCP project Ensuring that the findings of the FAO/GoE TCP project are shared with counterparts in the Bank. Bank representatives were invited to attend the FAO/GoE TCP project ‘Agro-Residues’ workshop.

2. Cooperation Bank-funded projects Bank-funded projects for boosting agricultural productivity may provide opportunities for agro-residues
utilization; but not during the tenure of the FAO/GoE TCP project – there were simply insufficient resources of time and/or manpower to make a difference.

3. **Potential collaborators** With more than US$1.4B invested in the country (and of the order 20 percent agricultural based), the potential remains obvious. Issues of effort, networking and opportunity arise. Technical MALR/ARC people need to develop and maintain contacts with the Bank to remain up-to-date with on-going initiatives which can be shared.

**Contacts World Bank**

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**A1.7 Other Agencies, Partners & Groups**

**Summary**

National development programs in Egypt are well supported by a host of friendly national and international agencies. All programs are concerned with people development and many relate directly to the agricultural sector and to the welfare of rural people. Most agencies/funds invest in issues that aim to provide improved environmental understanding and/or natural resource management. Many link logically into the work undertaken by the FAO/GoE TCP project. Insufficient information is available to determine where investments are on-going; and more investigation/exchange is required post-TCP project by the MALR/ARC team.

**A1.7.1 Introduction**

Limited time and limited manpower largely precluded the FAO/GoE TCP project team from further exploration of the extent of the ‘AgroResidues’ work underway within the portfolio of key international agencies and bilateral donors in the country - to provide partners, networks, synergy and catalysts. A measure of dialogue by phone and e-mail correspondence took place with some correspondents. Many other sources of information, funds and interest were not approached.
A1.7.2 Deutsche Gesellschaft fur Technische Zusammenarbeit GmbH

GTZ share a program of work with the GoE in two main sectors: (1.) Economic reform and market development; and (2.) Water resources management and reform. The former comprises training of technicians and the promotion of SMEs. The latter provides equal priority to wastewater management and improved irrigation (in separate programs). An eight year program of wastewater management is underway in Kafr El-Sheikh in the center of the rice producing areas of the Delta; and the main location of the FAO/GoE TCP project team (at the RR&TC). The GTZ Energy Newsletter is particularly useful for those working in renewable energy sectors (and is available at: www.gtz.de/energy). GTZ also provides a variety of technical literature covering waste management, transport, clean air in cities, fuel prices, etc. that link further to ‘agro-residues’ (and all of which is web-based and can be downloaded).

A1.7.3 Cooperazione Italiana (CI)

Italy is a major trading partner of Egypt and (second only to Germany in Europe). This is reflected in the international development program shared between the two countries with the Italian Ministry of Foreign Affairs/CI providing of the order US$50M disbursement annually. Much of this is multilateral funding, for example, FAO/Nile Basin water resources, UNIDO/SME support and World Conservation Union/sustainable hydro-resources. The focus of intervention areas are private sector (48 percent), environment (24 percent), social/health (25 percent) and the remainder is cultural heritage. Investment is used to encourage economic transition (to a market economy) and social development. Sharing a common heritage based on the Mediterranean Sea, Italy is active with structural reforms that link North Africa with the European Union. A handful of projects described on the CI website link activities to the work of the FAO/GoE TCP project; but more with supply of resources, social development and water management than with direct agro-residues initiatives. Italian-made industrial and farm equipment is widely used in Egypt. Further information to describe Italy/Egypt development opportunities is available at Egyptian-Italian Environmental Cooperation Program www.eiecop.org and www.uticairo.org.

A1.7.4 Other international sources of information

Agencies, banks, institutions, NGOs, companies, etc. involved with national development are numerous. Given the pragmatism required for access to funding, technical information and expertise, the following groups should be considered for further searching for potential partnership ventures:

- The League of Arab States
- OPEC Fund
- Gulf Organization for Industrial Consulting
- Gulf Cooperative Council (GCC)
- Arab Industrial Development and Mining Organization
- Arab Gulf Program for the United Nations Development Fund (AGFUND)
- Islamic Development Bank (IDB)
- European Union (EU)
- European Investment Bank (EIB)
- Arab Fund (AF)
- Abu Dhabi Fund (ADF)
- USAID
- Spain
- Canada/CIDA

Ranking sources in terms of disbursement provided for national development in 2004 listed USAID, EIB, EU, Arab Fund, World Bank, AfDB, Germany, Italy, Japan and the Abu Dhabi Fund as the major contributors with more than US$1,580M (of which USAID provided 33 percent). And, for bilateral disbursement, the order of contributions was USAID, Germany, Italy, Japan, Abu Dhabi Fund, Spain, DANIDA, CIDA, Netherlands and Switzerland with more than US$325M (of which, again, USAID provided 30 percent).
Annex 2. Activities of national development partners

A2.1 Egyptian Association for Science and Technologies Services

Summary

The Association comprises a group of key people that provide links between national resources of R&D/innovation and those in domestic industry who may be able to apply the technologies and/or develop the commercial applications required. The Association provides cost-effective consultancy assistance from among a cadre of almost 100 members/specialists (and their associated networks). The Association has developed firm links with UNIDO, and would like to do the same with FAO and the MALR/ARC project team. Herein are opportunities for introducing technical innovation and SME development into rural communities. The opportunity provided by Messrs Minar Engineering for the production of charcoal making equipment provides a case-in-point.

Background

The Egyptian Association for Science and Technologies Services (EAS&TS) is a not-for-profits organization established in 1975, and providing professional scientific and technical services to Egyptian industry that will help boosting national productivity. The Association is made up of more than 85 associate members who pay an annual subscription (currently about US$100), which enables them to remain informed of industrial development opportunities and to participate in projects that come within the remit of the Association. The Association was formed as the result of the gap perceived between producers/manufacturers (i.e. the commercial sector) and the national scientific institutions (i.e. part of the public sector) to serve as a conduit for linking local expertise with the marketplace. This has been particularly valuable for SMEs that make up more than 80 percent of the production base of the country. The Association remains, in reality, a cost-effective consultancy group of like-minded people. The Association is managed by a board of nine elected members – all of whom represent senior positions in local industry. The Chair and Vice-Chair, for example, are held by previous government ministers.
Program of work

Projects can be undertaken in three ways, i.e. (1.) Direct supervision (as financial resources may allow); (2.) Shared responsibility with others (covering sectors for which members have expertise); and (3.) Direct responsibility for projects recommended by members. Earnings come from profits made or profits shared. The Association has responsibilities to promote and encourage novel directions for shifting R&D into practical application. In recent times this has included projects in support of the environment, energy and natural resource industries. For example, the Association shared in the establishment of the Egypt National Cleaner Production Center (ENCPC), a joint investment between UNIDO and the Ministry of Trade & Industry; and the Plastics Technology Center in Alexandria. The Association shared recent workshops for ‘Chemical Leasing’ (January 2008) and ‘Sustainable Plastics from Agro-Food Wastes’ (March 2008) with UNIDO and industrial partners.

Courtesy of the Association and at the request of Minar Engineering of Cairo the FAO/GoE TCP project team was able to review company developments in charcoal-making equipment – aimed to replace the inefficiency of traditional practices (for energy consumption and conversion – wood/wastes to charcoal).

Issues/opportunities to consider

Typical of sector development in support of residues, energy, services and associated industries, Minar Engineering exemplify what can be done with the enthusiastic management in a well-informed company. Issues/opportunities are likely to take three directions:

1. Minar Engineering The company manufactures a range of charcoal/carbonizing plants (comprising kiln, condenser and associated control, heating and instrumentation equipment). The aim has been one of eventually replacing the estimated 2,500 traditional charcoal units producing wood charcoal, briquettes, powders and residual liquids/tars. The company currently has 5 working/exploratory plants with capacity 3-10 m² (and which sell within the range US$20,000-35,000). Plants are fired by natural gas, but any combustible materials can be used (including gases recycled from carbonizing processes). The company has been developing equipment and systems for more than three years; and is currently testing markets. They would like to participate in any downstream investment likely to follow-on from the FAO/GoE TCP project. If successful with pilot-scale charcoal plant, they see further
opportunities for developing a range of equipment that may exploit alternative sources of energy – wind, combustion, conversion, extraction and others in-line with government policy to reduce national dependency on petrochemical fuels.

2. Shared development UNIDO Given the encouraging track record of UNIDO with investment in industrial service providers with links to the Association, there is every opportunity for encouraging this partnership further to focus upon rural communities and to explore the post-production technologies that may add value, create SMEs/employment, boost income, etc.

3. Keeping abreast of R&D and innovation Contacts with the Association will boost the value of the network available to the FAO/GoE TCP project team – and convey information, interest, investment, etc. into distant parts of domestic industry (and encompassing all sectors, all scales and all levels of investment, etc.). Herein is a useful network that will extend the reach of the FAO/GoE TCP project (and the MALR/ARC and the Organization) to qualified people throughout domestic industry. For the effort involved, this is likely to be a ‘win-win’ opportunity. Networking could be enhanced with the development of an industry-wide e-newsletter based on the Association if this does not already exist. Insufficient information is available to determine the modus operandi and funding required with which to do so. External support will be required.

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A2.2 Soils, Water and Environment Research Institute (SWERY)

Summary

The resources of SWERI and its TCRAR training center in wastes management have not been exploited by the FAO/GoE project notwithstanding the considerable background available in technical sectors that have become widely promoted nationally in recent times – including renewable energy development, environmental care, more efficient utilization of natural resources and similar. Brief meetings held between the FAO/GoE project team have highlighted missed opportunities for shared exchange of information, skills and decision-making. Opportunities of this kind should continue to be explored. A review of the mandate of Training Center and the Institute may be of value into the next period.

Background

SWERI dates back more than 100 years and to the specialization of the Ministry of Public Works in the early 20th century. SWRI was formed in 1971 and, with environmental issues later taking priority, transformed into SWERI during the 1980s. The Training Center for Recycling of Agricultural Residues (TCRAR) in Qualyobia Governorate was established at the same time, thereby emphasizing the importance of training people and boosting socio-economic development within rural communities. It is not sufficient to explore the R&D of the science and technologies of natural resource management if producers remained ill-informed, lacked basic skills and were unable to exploit their resources to the full. SWERI has a mandate to make a difference.

Program of work

The work of SWERI is directly linked to the activities of the FAO/GoE TCP project – whether for conservation agriculture or agro-residues utilization. SWERI has undertaken extensive programs of work in support of residues recycling, environmental protection, pollution control, conversion of residues to fertilizer/compost, livestock feed, food/mushroom production, energy/biogas production, etc. within a number of integrated contracts/technical packages. The Institute has provided technical backstopping services nationally in support of surveys, feasibility studies, training, provision of TA, advice and evaluation, etc. See, for example, the contracted socio-economic study undertaken by SWERI in Sinbo Village in Gharbiya Governorate.50

50 SWERI and Sinbo Village Contract. A residues recycling study for Sinbo Village was undertaken in 2005 and provided an economic comparison of shifting from dependency
Issues/opportunities to consider

1. Shared ventures SWERI have not generally linked into the work of the FAO/GoE TCP project given the dispersed and competitive nature of funding and service provision within the ARC (and notwithstanding SWERI as a sister institute within the ARC). All elements of SWERI-linked technical R&D, investigation and reporting have been undertaken by National Consultants based at the ARC/RR&TC. This has provided for a more easily managed project team, but opportunities for boosting shared technical investment have, however, been missed. This should not detract from promoting shared ventures into the next period.

2. Biogas production TCRAR at Moshtohor was established more than 25-years earlier to provide a center for R&D and skills training in biogas technologies (as part of integrated waste management programmes). Given current interest in renewable energy resources within the country (with national targets of 20 percent power production from renewable resources by 2020) there is scope for revisiting the mandate of TCRAR to review a more pro-active and modern role (that may diverge from typical MALR/ARC programmes). Therein may be opportunities for links to the establishment of a national BioEnergy Center as promoted by UNIDO and others. See, for example, Megeed (2008).

Contacts SWERI

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A2.3 Agricultural Engineering Research Institute (AERI)

Summary

AERI work programs focusing on straw harvesting logistics, agro-industrial processing, small-scale energy production and similar have generally not been shared by the FAO/GoE TCP project team. This represents missed opportunities during the tenure of the project that should not continue through into the next period - where greater vision and larger budgets may become available for rural industrialization.

Background

Part of the ARC of the MALR, the AERI was established in 1991 and undertakes work in a number of classic agro-engineering sectors appropriate to Egyptian conditions. This includes mechanization, post-harvest technologies, agro-industries, biotechnologies, land and water engineering, plant production and protection, farming systems and agro-meteorology. The AERI provides support for education and training, R&D and technology transfer to domestic industry. With headquarters in central Cairo, the AERI employs more than 200 technical specialists. In recent times the AERI has undertaken work in sectors that link directly to the work of the FAO/GoE TCP project – manufacturing, composting, gasification and, importantly, logistics of straw harvesting.

Program of work

Manufacturing links directly to the requirements of local industry – with the AERI working in support of importers and others to determine the feasibility of manufacturing selected equipment for use by growers. Work of this kind has resulted in the manufacture of more than 200 Italian-designed conventional balers in Egypt (i.e. primarily assembly) during the period 2001-on. Work was shared with the Ministry of Environment to help providing baling services to growers. The AERI/Ministry of Environment shared a similar venture that resulted in the establishment of two factories for large-scale production of compost and, more recently, the AERI have assisted with the establishment of the Czech-financed briquette-making factory in the Delta. Support for gasification has come within the AERI energy programme, which has also involved providing TA to donors for sun- and wind-power energy resource development. Village-scale gasification plant has been proposed, and two pilot-scale Chinese-funded
gasification plants have been built in the Delta with supporting TA from the AERI.

The work of the AERI was explored twice during the tenure of the FAO/GoE TCP project, viz.: (1.). Logistics of straw harvesting, collection and storage; and (2.). Extraction of chemicals from straw.\textsuperscript{51} R&D programs were undertaken at the Rice Mechanization Center (RMC) close to the RR&TC at Kafr El-Sheikh in the Delta and at the AERI HQ in Cairo. Notwithstanding a free exchange of information, no documentation has been shared.

**Issues/opportunities to consider**

1. **Shared ventures** The FAO/GoE TCP project did not generally share in the work activities of ARC/AERI (and notwithstanding the close working relationship enjoyed between the RMC and RR&TC in Kafr El-Sheikh). Opportunities for exploiting the synergy of shared technical investment have been missed. This should not detract from promoting ventures of this kind into the next period.

2. **Technical compatibility** The ARC/RR&TC team has much to gain from the findings of the ARC/RMC in straw handling logistics, straw processing on- and off-farm and small-scale/rural community energy production. Competition for budgets, funds and professional leadership should not detract from the benefits to be gained of working more closely together.

**Contacts AERI**

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\textsuperscript{51} Chemical extracts. Reported earlier under Section 4 of Chapter 9.

Summary

Continuity of investment is essential for industrial development, and particularly where this will be based upon a relatively little known agricultural sector with limited economic potential. Such has been the case with the FAO/GoE TCP agro-residues project - with no immediate follow-on investment forthcoming. An appropriate concept/design is required that will attract donor funding. Given the extent of the support in the country by the donor community and interest in a range of socio-techno-economic sectors (all of which help to boost living standards), selecting and marketing ideas should not prove difficult.

A project has been designed in outline with donor investment of US$3.8M during a period of 4 years. Counterpart funding of the order US$2.25M is expected. Total investment estimated US$6M. The project will focus upon agro-residues industrial development with outputs that will help better define national agro-residue resources, provide methodologies for conversion and help establish pilot-scale R&D plant and equipment. The downstream potential is estimated at more than US$100M industrial development that will help absorb the estimated 600,000 new people entering the work force annually.

Project title

‘Agro-industrial rice residues utilization in Egypt’ (or similar).

Government Executing Agency

Ministry of Agriculture & Land Reclamation.

Context and background

Success with doubling the yields of rice available from use of the same resources of people, land and water during the past 20 years has resulted in the production of estimated 4 Mt crop residues (i.e. straw & hulls) for which limited markets currently exist. This has lead to widespread burning of crop residues during the crop harvesting season; and has severely polluted the skies over the main rice growing areas and, importantly, over residential urban areas close by. This is no longer tenable, and laws have been enacted
to make crop burning illegal. However, changes in burning practices will be
slow whilst rice residues continue to have low economic value. Only when
residues rise in price to acceptable market values, will farmers make effort
to harvest and sell them. Given the small-scale nature of production,
however, service industries for logistically handling straw wastes (and
perhaps also for processing pre-delivery) are unlikely to develop without
investment from the public sector.

Egypt has the technical resources with which to make the changes
required - both on-farm and within industry. Of the order 25 percent of all
rice residues are used on-farm with estimated 3 Mt of residues wasted.
Industrial ventures for energy production, livestock feed, composting/land
reclamation, paper/board manufacture and others are planned or underway.

Catalytic funds of the order US$350,000 have been provided within
the FAO/GoE project TCP/EGY/3102 ‘Rice Straw Management and
Conservation of Environment’ for investigating issues involved with rice
residues utilization and exploring sector-related past, on-going and planned
activities. Continuity of investment will enable the appropriate R&D and
quasi-commercial models to be devised for processing residues on
industrial-scale during the next 10 years. The long-term aim will be to
courage socio-economic development of rural communities within
sustainable agro-production systems in which all crop residues are used
effectively. Burning residues on-farm as waste is no longer tenable.

Objectives

Developmental objective: To identify and encourage the exploitation of rice
straw utilization on-farm and within rural agro-industries to add value,
create wealth and employment and to foster the socio-economic
development of local communities.

Specific objectives:

1. To undertake techno-economic surveys and develop strategies for
industrial-scale utilization of rice straw.
2. To introduce modern and cost-effective materials handling systems for
collecting, storing and transporting residues in rice-producing areas.
3. To promote the introduction of appropriate ventures for industrial-scale
processing of rice residues.
4. To introduce effective programs that will help boost investment in
industrial-scale straw processing and utilization ventures.
Outputs

Summarized within the four objectives proposed:

1. Techno-economic surveys completed
   - Existing agro-industrial residues and processing ventures surveyed.
   - Techno-economic studies undertaken and the viability of different choices and/or products and/or markets identified.
   - Strategies, policy tools, regulations and economic incentives devised and in place.
   - Partner institutions, agencies, companies, etc. identified and strengthened.

2. Modern materials handling systems introduced
   - Appropriate logistical models for harvesting, handling, storing and transporting residues explored and developed; and promoted to industry.
   - Post-R&D ventures introduced for harvesting, handling, storing and transporting residues in key rice-producing areas; appropriate to small-scale production and/or industrial-scale processing.
   - Training undertaken for recommended materials handling systems; appropriate training materials devised and published.
   - Role of the private sector highlighted and encouraged.

3. Industrial-scale processing recognized
   - Post-production technologies for adding value to residues identified and demonstrated.
   - Markets for different products recognized and promoted; with respect to scale of production.
   - Training undertaken in support of modules and practices for industrial-scale processing.

4. Promotion institutional support for agro-industrial processing
   - Portfolio of investment profiles developed for different industrial-scale investments; and different products/markets.
   - Promotion of opportunities available to domestic and international industrial investors.
   - Establish modus operandi of private-public-partnership facilities.
Project executors

Shared venture FAO Rome, FAO Cairo, UNIDO Cairo and the Government of Egypt. The modus operandi for sharing responsibility and access to resources will need to be determined; with FAO taking the lead for external advisory services, and UNIDO and FAO taking joint responsibility for in-country activities.

Investment required/period

Expected US$3.8M donor investment for a period minimum of four years. Funds to be augmented with Government of Egypt support estimated US$0.75M and selected commercial investors (for separate module application) with value US$1.5M (i.e. five ventures of value US$0.3M each). Total investment expected of the order US$6M.

Project management

National Project Coordinator (NPC) will lead the project. During Years 1 & 2 the NPC will have the support of a Chief Technical Advisor (CTA). A service office will be established. National experts will be identified and assigned to the project from the national counterpart agencies. A project management committee (PMC) will be established to provide guidance and advice to the NPC/CTA management team.

Capacity building

Capacity building is essential to provide a bridge into the industrial needs of rice producers and industrial service providers. Linked into national counterpart organizations – shared equally and jointly with the MALR and Ministry of Environment; that national experts are able to take responsibility from the outset. National team is expected to comprise 30 percent representatives from the private sector – to include those already involved with industrial investment in composting, energy, livestock feed and similar.
Annex 4. Contacts ‘Agro-Residues’ Network

Summary

Listing the many people who currently make up the ‘Agro-Residues’ network established by the FAO/GoE TCP project during the period 2007-2008. Incumbents rapidly move on, but institutions, agencies, ministries and others remain in place, and their respective offices, and street and telecommunication addresses stay much the same.

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