TABLE 3
**FAO AQUASTAT update: country irrigation statistics and areas under water management**

| Country | Year | Area equipped for irrigation | Non-equipped cultivated wetlands & valley bottoms | Non-equipped flood recession cropping area | Total water managed area | % of irrigation potential | % of cultivated area |
|---|---|---|---|---|---|---|---|
| Unit | | ha | ha | ha | ha | % | % |
| | | (1) | (2) | (3) | (4)=(1)+(2)+(3) | (5) | (6) |
| Algeria | 2001 | 569 418 | - | - | 569 418 | 112 | 6.9 |
| Angola | 1975 | 80 000 | 320 000 | - | 400 000 | 6 | 11.8 |
| Benin | 2002 | 12 258 | 6 988 | - | 19 246 | 6 | 0.7 |
| Botswana | 2002 | 1 439 | - | 6 500 | 7 939 | 61 | 2.1 |
| Burkina Faso | 2001 | 25 000 | 21 400 | - | 46 400 | 28 | 1.1 |
| Burundi | 2000 | 21 430 | 83 000 | - | 104 430 | 49 | 7.9 |
| Cameroon | 2000 | 25 654 | - | - | 25 654 | 9 | 0.4 |
| Cape Verde | 1997 | 2 780 | - | - | 2 780 | 89 | 6.2 |
| Central African Republic | 1987 | 135 | 500 | - | 635 | 0 | 0.0 |
| Chad | 2002 | 30 273 | - | 125 000 | 155 273 | 46 | 4.3 |
| Comoros | 1987 | 130 | - | - | 130 | 43 | 0.1 |
| Congo | 1993 | 2 000 | - | - | 2 000 | 1 | 1.0 |
| Côte d'Ivoire | 1994 | 72 750 | 16 250 | - | 89 000 | 19 | 1.4 |
| Democratic Republic of the Congo | 1995 | 10 500 | 2 000 | 1 000 | 13 500 | 0 | 0.2 |
| Djibouti | 1999 | 1 012 | - | - | 1 012 | 42 | 100.0 |
| Egypt | 2002 | 3 422 178 | - | - | 3 422 178 | 77 | 100.0 |
| Equatorial Guinea | - | - | - | - | - | 0 | 0.0 |
| Eritrea | 1993 | 21 590 | - | - | 21 590 | 12 | 4.3 |
| Ethiopia | 2001 | 289 530 | - | - | 289 530 | 11 | 2.5 |
| Gabon | 1987 | 4 450 | - | - | 4 450 | 1 | 1.0 |
| Gambia | 1999 | 2 149 | 13 170 | - | 15 319 | 19 | 6.8 |
| Ghana | 2000 | 30 900 | - | - | 30 900 | 2 | 0.5 |
| Guinea | 2002 | 94 914 | - | - | 94 914 | 18 | 6.2 |
| Guinea-Bissau | 1996 | 22 558 | 29 368 | - | 51 926 | 18 | 11.7 |
| Kenya | 2003 | 103 203 | 6 415 | - | 109 618 | 31 | 2.1 |
| Lesotho | 1999 | 2 637 | - | - | 2 637 | 21 | 0.8 |
| Liberia | 1987 | 2 100 | 18 000 | - | 20 100 | 3 | 3.3 |
| Libyan Arab Jamahiriya | 2000 | 470 000 | - | - | 470 000 | 1175 | 21.9 |
| Madagascar | 2000 | 1 086 291 | - | 9 750 | 1 096 041 | 72 | 31.3 |
| Malawi | 2002 | 56 390 | 61 900 | - | 118 290 | 73 | 4.8 |
| Mali | 2000 | 235 791 | - | 60 000 | 295 791 | 52 | 6.3 |
| Mauritania | 1994 | 45 012 | 32 786 | 30 984 | 108 782 | 44 | 22.7 |
| Mauritius | 2002 | 21 222 | - | - | 21 222 | 64 | 20.0 |
| Morocco | 2000 | 1 484 160 | - | - | 1 484 160 | 89 | 16.0 |
| Mozambique | 2001 | 118 120 | - | - | 118 120 | 4 | 2.8 |
| Namibia | 2002 | 7 573 | - | 2 000 | 9 573 | 20 | 1.2 |
| Niger | 2000 | 73 663 | - | 12 000 | 85 663 | 32 | 1.9 |
| Nigeria | 2004 | 293 117 | - | 681 914 | 975 031 | 42 | 3.0 |
| Rwanda | 2000 | 8 500 | 94 000 | - | 102 500 | 62 | 8.9 |
| Sao Tome and Principe | 1991 | 9 700 | - | - | 9 700 | 91 | 23.7 |
| Senegal | 2002 | 119 680 | - | 30 000 | 149 680 | 37 | 6.0 |
| Seychelles | 2003 | 260 | - | - | 260 | 26 | 3.7 |
| Sierra Leone | 1992 | 29 360 | 126 000 | - | 155 360 | 19 | 28.8 |
| Somalia | 2003 | 200 000 | - | - | 200 000 | 83 | 18.7 |
| South Africa | 2000 | 1 498 000 | - | - | 1 498 000 | 100 | 9.5 |
| Sudan | 2000 | 1 863 000 | - | - | 1 863 000 | 67 | 11.2 |
| Swaziland | 2000 | 49 843 | - | - | 49 843 | 53 | 26.2 |
| United Republic of Tanzania | 2002 | 184 330 | - | - | 184 330 | 9 | 3.6 |
| Togo | 1996 | 7 300 | - | - | 7 300 | 4 | 0.3 |
| Tunisia | 2000 | 394 000 | - | - | 394 000 | 70 | 7.9 |
| Uganda | 1998 | 9 150 | 49 780 | - | 58 930 | 65 | 0.8 |
| Zambia | 2002 | 155 912 | 100 000 | 10 | 255 922 | 49 | 4.8 |
| Zimbabwe | 1999 | 173 513 | 20 000 | - | 193 513 | 53 | 5.8 |
| **Africa total** | - | **13 444 875** | **1 001 557** | **959 158** | **15 405 590** | | **7.3** |
| **sub-Saharan Africa total** | - | **7 105 119** | **1 001 557** | **959 158** | **9 065 834** | | |

Source: FAO, 2005a.

may cover parts of a single nation or span national boundaries. Only by chance will a market naturally cover the same area as a nation, but the additional costs of trading across national boundaries do on occasion result in the creation of national markets with a complete absence of external trade. In such cases, the prices of the commodity

TABLE 4
**AQUASTAT regional distribution of area under water management**

| Region* | Irrigation | | Non-equipped cultivated wetlands and inland valley bottoms | | Non-equipped flood recession cropping area | | Full water management | |
|---|---|---|---|---|---|---|---|---|
| | Area (ha) | % of total | Area (ha) | % of total | Area (ha) | % of total | Area (ha) | % of all Africa |
| Northern | 6 339 756 | 100 | - | - | - | - | 6 339 756 | 41 |
| Sudano-Sahelian | 2 619 950 | 89 | 67 356 | 2 | 257 984 | 9 | 2 945 290 | 19 |
| Gulf of Guinea | 565 257 | 39 | 196 606 | 14 | 681 914 | 47 | 1 443 777 | 9 |
| Central | 132 439 | 29 | 322 500 | 71 | 1 000 | 0 | 455 939 | 3 |
| Eastern | 616 143 | 73 | 233 195 | 27 | - | - | 849 338 | 6 |
| Southern | 2 063 427 | 91 | 181 900 | 8 | 8 510 | 1 | 2 253 837 | 15 |
| Indian Ocean Islands | 1 107 903 | 99 | - | - | 9 750 | 1 | 1 117 653 | 7 |
| Total | 13 444 875 | 87 | 1 001 557 | 7 | 959 158 | 6 | 15 405 590 | 100 |

*See Figure 3 for regional groupings.
Source: FAO, 2005a.

are determined by supply and demand either in a single national market or in a set of self-contained subnational markets.

The impact of a localized increase in production from, for example, a new irrigation scheme depends critically on the structure of the market into which the commodity sells and the impact that the production has on the structure of the market.

The impact of a localized increase in production from, for example, a new irrigation scheme depends critically on the structure of the market into which the commodity sells and the impact that the production has on the structure of the market. For example, prior to the establishment of the scheme, there may be a small self-contained localized market for the commodity. As the irrigated production comes on stream, its first impact is to increase supply into this market and to reduce local prices. As production expands further, prices may fall to a point where the commodity can be exported profitably from the locality into another domestic market, thereby in effect integrating the two markets into a single new market. At some point, as production continues to expand, domestic prices may eventually fall to a level where greater returns are achievable by exporting across the national boundary. This integrates the domestic market with markets in other countries. Once this happens, prices at each point in domestic marketing chains tend to move towards the selling price in the most remunerative foreign market net of the processing and marketing costs and profit margins incurred in delivering the product to that market. Such market-determined domestic prices for exported commodities are normally termed "export parity prices".

The above example assumes that there is initially no national importation of the commodity. If the commodity were being imported in the initial situation, the new irrigated production would compete with imports, and the producer price would be a function of the import price. In such situations, domestic market-determined prices at each point that the commodity changes hands are normally termed "import parity prices". The import parity producer price at the irrigation scheme would be equal to the price at the point where competition with imports takes place minus the processing and marketing costs incurred from the scheme to this point.

As local production expands, the point of competition tends to move away towards the point of importation. This reduces progressively the unit cost of the imports at the point of competition and increases the marketing costs incurred in delivering the product from the irrigation scheme to this point. This in turn leads to a progressive reduction in the producer price. Once domestic output increases to the point where domestic prices fall below import parity, imports cease and domestic prices are determined solely by domestic supply and demand with no foreign trade. Further domestic production increases could eventually lead to domestic prices falling to export parity. Exports would then commence and domestic prices would again become a function of supply and demand in external markets. However, domestic prices would now be lower than in an import situation.

In sub-Saharan Africa countries, export parity prices tend to be substantially lower than import parity prices, especially as one moves back up marketing chains to the farmgate. A switch from import parity through domestic equilibrium to export parity then has a dramatic impact on producer prices. This is particularly the case for landlocked nations that have no natural nearby markets and must export to distant markets, e.g. Europe. Within sub-Saharan Africa, the generally poor performance of agriculture means that there are few recent examples of sustained switches from import to export parity. However, annual switches are a relatively frequent occurrence for many of the maize-based food economies of eastern, central and southern Africa, from Ethiopia to South Africa, whose grain production varies sharply from year-to-year. Price-inelastic demand means that market prices fluctuate considerably as nations or whole regional national groupings swing between surplus and deficit depending on the timing and abundance of rainfall. In general, the geographic extent of a swing region and the location of the point of trade within this region determine the size of the price swings that occur. For example, in Malawi, which is at the centre of a set of countries that tend to swing together from maize surplus to deficit, producer prices for maize vary dramatically from year to year. In the occasional year when Malawi is in deficit but can, for example, import from neighbouring Zambia, domestic price rises are comparatively moderate compared with when there is an aggregate regional deficit and Malawian traders must import using very high-cost transport links from the world market.

Within sub-Saharan Africa, the generally poor performance of agriculture means that there are few recent examples of sustained switches from import to export parity. However, annual switches are a relatively frequent occurrence for many of the maize-based food economies of eastern, central and southern Africa, from Ethiopia to South Africa, whose grain production varies sharply from year-to-year.

The main impact of irrigation is to increase the value of agricultural output through increasing yields per hectare per year (cropping intensity) and through changing the structure of agricultural output towards crops that have a higher per-hectare value. The main market-related constraint on the expansion of irrigation is the impact that increases in the supply of agricultural commodities have on their prices. The main impact is on the prices of the irrigated commodities themselves, but the prices of competing and complementary irrigated and non-irrigated commodities are also usually affected. These impacts may have little or no effect on commercial incentives to expand irrigation as individual producers are usually too small for their increases in output to have a significant effect on market prices. However, investments in irrigation that affect groups of farmers may well affect prices. For example, a large public investment in the irrigation of maize may reduce the domestic producer and retail prices of both maize and competing staple food crops, harming both rainfed and irrigating surplus producers of staples and benefiting all net consumers. Governments, donors and international financing agencies should take such impacts into account in their decision-making.

In practice, the effects of increased irrigation on prices and incomes are likely to be complex, with changes in prices and the welfare of households differing spatially and by income group. For example, in a net rice-importing country, the expansion of irrigation that is devoted to the growing of rice on land that was formally used for the growing of staple root crops would have a number of effects. It would reduce the consumer price of rice in the irrigated growing area provided that the prices of domestically produced rice were determined by competition between this rice and imported rice at some point away from the growing area, as would normally be the case. However, it would have no impact on rice prices in areas where imported rice remained cheaper. In such areas, prices would remain at their former import parity levels. The production and supply of staple root crops would tend to fall and their prices in the production area and possibly also further afield would increase, although this effect would be moderated by higher-income consumers of root crops switching partially to rice. To the extent that the poorest sectors of the community would remain net buyers of root crops and would still not consume rice, they would tend to be worse off. However, some might obtain employment in the new irrigated paddy fields or be allocated an irrigated plot, and this would offset either partially or fully the adverse impact of the increase in the price of their staple.

The most important factor that determines the impact of increased irrigation on price is the size of the production increase relative to the size of the potential market.

The most important factor that determines the impact of increased irrigation on price is the size of the production increase relative to the size of the potential market. This varies dramatically between products depending on the extent to which they are traded. Highly perishable, low value-to-weight crops, such as kale and cabbages, tend to have small, localized markets that, depending upon transport systems, may range from a few miles in extent to subnational or national. Crops that are exported from the sub-Saharan region, such as cotton or coffee, or are imported, such as wheat and rice, sell into markets that are global in extent. A localized increase in irrigated supply can be expected to have a major impact on prices that are determined in localized markets, some impact on prices determined in markets that are nationwide, but little or no impact on the domestic prices of internationally traded commodities unless this changes the direction of flow of the commodity.

From the above, it is evident that the prices received by producers for new irrigated production are critically dependent *inter alia* on: the location of this production; the structure of the domestic, regional and international markets; and the magnitude of the increases in output to which this new irrigation leads relative to the size of each of these markets. Chapter 6 discusses this further in the context of sub-Saharan Africa national and regional production.

## PROCESSING AND MARKETING SYSTEMS IN SUB-SAHARAN AFRICA

sub-Saharan Africa has witnessed an extensive liberalization of processing and marketing systems in the past two decades. This has led to systems with radically changed organizational and economic characteristics. Staple grains are no longer traded by state enterprises at fixed seasonal and panterritorial prices, and there is greatly reduced state control of the importing and exporting of staples. Single-channel state-run marketing systems for export crops based on state boards and caisse de stabilisation have largely disappeared, as have attempts to stabilize export crop producer prices.

Private trading systems have emerged rapidly as state systems have collapsed or been phased out. Although these are generally competitive, the extent of competition varies markedly between countries and also between high-density and remote farming areas within countries. The new systems have three main characteristics:

- they are inefficient owing to: a lack of grades and standards, the reluctance and inability of farmers and traders to store seasonally, poor physical and electronic communications, and inadequate information;
- the prices facing farmers are unpredictable and unstable;
- the former interlocking at the farm level of crop purchase and the provision of input and credit has largely collapsed following the phasing out of single-channel input supply and marketing systems.

Contract farming has emerged as an important means of replacing the single-channel systems. However, such farming is only appropriate for crops that the supplier of inputs and other services to farmers can be assured of buying. Other crops (particularly food crops grown by small-scale farmers) are vulnerable to "side selling" and are largely unsuited to contract farming (FAO, 2001).

There is now immense diversity in the structure and practices embodied in agricultural marketing systems in sub-Saharan Africa as market forces have led to the development of systems tailored to the production, processing and marketing characteristics of each commodity.

## SELF-SUFFICIENCY AS AN OBJECTIVE AND A TOOL IN DEMAND ANALYSIS

Sub-Saharan Africa governments have pursued national self-sufficiency in basic foodstuffs as a means of ensuring an adequate availability of food. This is rational where a nation or region is unable to import or anticipates that it may be prevented from doing so at some time in the future. However, the pursuit of self-sufficiency as a goal in itself necessarily involves sacrifices in terms of economic efficiency as it inhibits the agriculture sector being structured on the basis of comparative advantage and prevents the exploitation of the full gains from specialization and trade. In addition, by not necessarily making the best use of human and natural resource endowment, self-sufficiency can be very expensive in social development and environmental terms.

Once annual national exports of a commodity exceed annual national imports, a country is said to be self-sufficient. However, this conventional definition of self-sufficiency frequently masks substantial outward and inward trade in natural markets that span the country's borders. In addition, if the commodity cannot be readily stored, the country may still be dependent on imports at particular times of the year.

However, this conventional definition of self-sufficiency frequently masks substantial outward and inward trade in natural markets that span the country's borders. In addition, if the commodity cannot be readily stored, the country may still be dependent on imports at particular times of the year.

Increased production within one or more countries of a subcontinental region may similarly lead to statistical annual self-sufficiency of the region. As with a statistically self-sufficient nation, the region is also likely to both export and import after achieving annual self-sufficiency as a result of the seasonality of production and the existence of natural cross-border markets. Regional data on self-sufficiency have the further drawback that a full set of data on trade between countries in sub-Saharan Africa is not readily available and nor is that for the trade of sub-Saharan Africa regions with the rest of the world. As a consequence, it is not possible to estimate regional imports and exports. Thus, the extent of self-sufficiency is usually estimated and projected simply by comparing annual regional production with consumption. As much of the trade of countries within individual sub-Saharan Africa regions is with countries outside the region (and frequently also outside sub-Saharan Africa), it is possible for a region to be statistically self-sufficient in a commodity while some of its countries continue to be dependent on imports from outside the region.

For the above reasons, the available statistics relating to both national and regional self-sufficiency have a very limited and specific meaning. They refer simply to the ratio of annual production to annual consumption in the nation or the region in question. In the case of individual nations, they mask the fact that imports may be necessary at certain times of the year even though annual production is equal to or exceeds annual consumption. They also mask the fact that the location of production and consumption areas near national borders may lead at any point in time to cross-border sales in one part of the country and cross-border purchases in another part. In the case of regions, conventional measurements of self-sufficiency embody both these characteristics and have the further drawback that they underestimate annual extra-regional trade in the commodity.

Notwithstanding these reservations, several reasons make it both worthwhile and necessary to examine the demand for sub-Saharan Africa irrigated production in terms of self-sufficiency. First, estimates and projections of national and regional self-sufficiency are useful in that they indicate the extent to which annual national and regional production falls short of annual demand and give an indication of the additional quantities that can be produced before prices fall from import to export parity. Second, many sub-Saharan Africa governments still consider self-sufficiency in basic foodstuffs an important objective. This is particularly the case in countries where white maize is the staple and where imports of more readily available yellow maize are highly visible and viewed as a sign of national failure. Third, much of the potential for regional trade in sub-Saharan Africa remains unexploited because of infrastructure developed during the colonial period that was tailored to trading with the metropolitan country. There is now a desire for greater self-reliance within sub-Saharan Africa and within its regions and, consequently, an increasing emphasis on regional trade by governments, by regional and Africa-wide bodies, and by national, regional and international aid and financing agencies. Fourth, most regions within sub-Saharan Africa remain far from self-sufficient in most basic foodstuffs. The final reason is one of analytical necessity. The large number of countries in sub-Saharan Africa, coupled with a lack of readily available data on national exports of commodities analysed by destination, means that it is only possible to undertake an analysis of demand that covers all sub-Saharan Africa nations in terms of differences between projected annual consumption and production. However, this analytical focus on self-sufficiency does not imply that self-sufficiency is a rational or desirable objective.

## INCREASED IRRIGATION IN SUB-SAHARAN AFRICA AND ITS IMPACT ON COMMODITY PRICES

The extent of the impact on price of a given increase in supply depends on two factors: (i) the percentage increase in total supply to the market; and (ii) the sensitivity of the market price to changes in supply. The former depends on the total size of the existing market, the latter on the price elasticity of demand.

National governments will be interested in the impact of an investment in irrigation both on the economic and financial profitability of that investment and on the welfare of all national producers and consumers of the commodity. Thus, they will be interested not only in the impact on the prices received by farmers participating in the new irrigation but also on other members of the national population. International donors and international financial institution (IFIs) should logically look wider than this and also take account of the impact on prices worldwide.

For grains, projections made using the IMPACT model of the International Food Policy Research Institute (IFPRI) indicate that increased irrigation in Africa will have only a small impact on world grain prices (Rosegrant and Perez, 1997). This is principally because of the small size of African production compared with that of the world. This suggests that donors, IFIs and other external agencies should focus on national and regional price impacts when assessing potential investments. Increases in irrigated output could have significant impacts on both irrigated and rainfed producers in the country in question and the region through their effect on prices in localized markets and on the structure of markets and prices within the country and the region. The impacts are likely to differ markedly between different categories of crops. Chapter 6 discusses the probable magnitude and direction of impacts.

This suggests that donors, IFIs and other external agencies should focus on national and regional price impacts when assessing potential investments.

## HOW IRRIGATION RESPONDS TO DEMAND – THE PROCESS

Despite the significant range of tangible benefits that irrigation can provide, it is not a panacea for all problems and not always assured of immediate success, particularly where public agencies prove too rigid (incapable of responding to farmers' needs). In many cases, the installed asset base (equipped area) is underutilized. The poor performance of Nigerian public-sector irrigation is a case in point (Box 2) – only 30 percent of the federally funded equipped area is cropped. This raises questions as to the circumstances under which the private sector will engage in large-scale irrigation, and the circumstances under which new small-scale schemes become viable.

Insofar as the structure of the markets for irrigated produce conditions the pattern and flow of demand, the structure of the irrigated subsector in each country of the region is also critical in determining how producers can respond to changing demand patterns. For example, private commercial scale-irrigation in Nigeria is almost moribund whereas commercial sugar dominates the subsector in Swaziland; yet the opposite is the case with respect to fadama and other smallholder irrigation, which, although constrained in Swaziland, represents a significant livelihood opportunity in Nigeria.

BOX 2

### The structure of irrigation in Nigeria

| Scheme Grouping | [1]2000 Planned Irrigable Area (ha) | [2]2004 Planned Irrigable Area (ha) | Area Equipped for Irrigation (ha) | | Area Actually Under Irrigation (ha) | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2000 | [2]2004 | [1]1990–91 | [1]1995–96 | [1]1999–2000 | 2003–200 |
| **RBDA Schemes** | | | | | | | | |
| Anambra-Imo | 11 300 | 11 450 | 3 936 | 3941 | 3 850 | 0 | 15 | 10 |
| Benin-Owena | 7 455 | 10 380 | 831 | 317 | 0 | 402 | 5 | 0 |
| Chad Basin | 106 630 | 101 900 | 27 500 | 26 180 | 15 500 | 2 250 | 1 650 | 1000 |
| Cross River | 717 | 8 477 | 717 | 364 | 0 | 72 | 42 | 40 |
| Hadejia Jama'Are | 83 700 | 40 500 | 21 045 | 18 475 | 14 000 | 12 925 | 16 930 | 21 000 |
| Lower Benue | 10 700 | 12 215 | 880 | 1 310 | 125 | 137 | 30 | 70 |
| Niger Delta | 7 250 | 6 850 | 722 | 187 | 100 | 0 | 53 | 0 |
| Lower Niger | 9 510 | 16 577 | 1 615 | 1 344 | 400 | 373 | 230 | 115 |
| Upper Niger | 3 485 | 53 895 | 2 928 | 3 697 | {[5]} | 310 | 345 | 722 |
| Ogun-Osun | 33 679 | 28 574 | 6 328 | 512 | 140 | 132 | 152 | 110 |
| Sokoto Rima | 52 812 | 62 390 | 15 445 | 27 580 | 11 000 | 0 | 6 180 | 5 290 |
| Upper Benue | 58 000 | 63 200 | 7 550 | 8 410 | 6 150 | 7 230 | 3 860 | 783 |
| **Sub Total** | **397 238** | **416 408** | **89 497** | **92 317** | **51 265** | **23 831** | **29 492** | **29 140** |
| % Planned | | 100% | 21% | 22% | 12% | 6% | 7% | 7% |
| % Developed | | | | 100% | 53% | 24% | 30% | 30% |
| **State Irrigation Schemes** | 16 000 | 16 000 | 12 200 | 12 200 | 6 900 | n/a. | 6 000$_e$ | 6 700$_e$ |
| Private Sector : | | | | | | | | |
| Bacita Sugar | 9 000 | 9 000 | 5 600 | 5 600 | 5 000 | 7 000 | 3 000$_e$ | 0 |
| Savannah Sugar[3] | (12 000) | (12 000) | (7 000) | (7000) | (6 000) | (5 500) | (3 200) | (500) |
| Other : | | | | | | | | |
| Fadama[4] | 55 000 | 55 000 | 55 000 | 55 000 | 18 000 | 30 000 | 55 000 | 55 000 |
| Private Small Scale | 128 000 | 128 000 | 128 000 | 128 000 | 128 000 | 128 000 | 128 000 | 128 000 |
| **Totals (ha)** | **605 238** | **624 408** | **290 297** | **293 117** | **209 165** | **n/a** | **221 492** | **218 840** |

[1] FAO: Irrigation Sub sector Study (Nigeria), September 2000, unless otherwise specified.
[2]FMWR 2004 estimates for planned and developed
[3]Savannah Sugar Company data included in Upper Benue RBDA
[4]Fadama figures from the World Bank Appraisal (Feb 1992) and the later ICR (April 2000) of the National Fadama Development Project – ICR figures not verified in the field and based on number of pumps distributed.
[5]Lower and Upper Niger one RBDA in 1991
"e" refers to estimated figures; n/a., information not available and estimate not possible.
Recession and moisture retention farming excluded.

Source: FAO (2004).

BOX 3

**Raising demand for irrigation**
**Reforms under the Agriculture Sector Development Strategy, United Republic of Tanzania**

United Republic of Tanzania's *Agriculture Sector Development Strategy* (ASDS), which was published in October 2001, comprises a set of innovative and practical actions intended to stimulate agricultural growth and reduce rural poverty. These include a focus on commercialization of the agricultural sector and increasing its **productivity** and **profitability**.

Arrangements for implementation of the ASDS are elaborated in the *Agriculture Sector Development Programme* (ASDP) *Draft Framework and Process Document* (September 2002). At the heart of ASDP is a sector-wide approach to changing the function of central government from an executive role to a normative one, to empowering local government and communities to reassume control of their planning and implementation processes, and to encouraging private sector participation in all aspects of agriculture – including investment, processing and marketing. Under this new approach, 70-80% of public (government and/or donor) funding of the sector will now be managed by district councils and utilized through *District Agricultural Development Plans* (DADPs). Greater use will be made of outsourcing through contracts with private sector service providers, and greater awareness of cross cutting issues, including gender and the environment, will also be promoted.

The new approach will require a transformation in the way public investments in the smallholder irrigation subsector are analysed, planned and implemented. In conformity with the ASDS and ASDP, planning and implementation of smallholder irrigation subsector investment projects must now be based on the need for them to be **driven by irrigators** (or potential irrigators), **responsive to market opportunities**, **coordinated at the local level** and **profitable**. This implies a need for more critical analysis of proposed investments and greater farmer participation in this process and that of their subsequent planning and implementation. It also implies a need to recognize that participation means more than mere consultation and that it takes time. It furthermore implies a need to recognize that farmers are the best judges of their own investment priorities and that these may not necessarily include investment in physical irrigation works, which do not always present the best opportunities for increasing output and incomes. Farmers may instead, for example, have identified a marketing opportunity or constraint that, if seized or addressed, would achieve their objectives more effectively.

*Source: Ministry of Agriculture and Food Security, United Republic of Tanzania (2003)*

Because of differences such as these, any attempt to justify more irrigation would sensibly do so on the basis of the demands of farmers and those to whom they sell instead of the wishes of those that see political or other advantage in the supply of more infrastructure (Box 3). Therefore, the scope of this study is oriented towards examining markets for irrigated produce. Clearly this analysis does not exist in isolation and other component studies need to be referred to appraise the process as through which investment will be mobilized and sustained.

Equally, it should be understood that the term irrigation describes a wide range of physical interventions, each or any of which may be appropriate depending on: local conditions including natural resource endowments; levels of producer/market sophistication; and realistic opportunities for added-value. The range itself begins with traditional recession agriculture, water harvesting or temporary village weirs (usually seasonal) and ends with precision systems that are automatically controlled by tensiometres computers, which as well as controlling water delivery and distribution also factor in the unit costs of water and compare it with probable farmgate prices before delivering specific and optimal amounts of water to the rootzone or subcanopies of the crops involved. Between these extremes are varying degrees of complexity and sophistication encompassing gravity fed, spate irrigation, basin irrigation, surge irrigation, gravity or pumped furrow irrigation, sprinkler, centre-pivot or drip/trickle systems, each or any of which could be managed by state service providers, the users themselves or commercial enterprises.

Therefore, an irrigation subsector is rather more than mere hardware and technology. It has both physical ('hard') and non-physical ('soft institutional') elements that constitute a specific functional 'structure' with a mix of irrigation styles and management approaches.

Consequently, there is little point in deciding whether or not the supply of agricultural commodities in sub-Saharan Africa could be increased by investing in more public-sector irrigation or by removing constraints on private-sector investment by both traditional farmers and commercial farmers. There is no real doubt that it could. Hence, the real questions are, first, should the supply of irrigated agricultural commodities be increased and what are the opportunity costs? Second, at what scale in terms of both physical and non-physical interventions and in relation to demand (markets)? Third, what lessons can be learned from the performance of past investments? Finally, to what extent can production risks be managed by the application of irrigation technology?

### Physical interventions

Physical interventions can be placed into four categories. First, there is rehabilitation of existing infrastructure. This would be a waste of time in the absence of an understanding as to why the infrastructure has fallen into disrepair. However, if these reasons can be addressed convincingly during the rehabilitation project cycle, then rehabilitation has the potential to produce the best economic results because of the sunk costs involved. Second, there is the upgrading of existing schemes (which might be carried out at the same time as rehabilitation). Upgrading is usually intended to facilitate more equitable, accurate and efficient water distribution but it can be necessary to facilitate a shift towards higher-value farming systems or the adoption of improved varieties. Third, there are new run-of-river schemes, which will themselves vary from easy to difficult in both technical and social terms as well as costs – small-scale interventions/ fadama. Finally, there are new storage-based schemes. These introduce a new set of environmental, social and economic challenges, not least options for small-scale local storage close to watersheds (thereby taking advantage of reuse potential, enhanced and diversified local livelihoods), the recharge of linked aquifers, or the replenishment of large dams and impounded areas in valley bottoms. The latter may achieve economies of scale while possibly gaining additional municipal water supply and hydropower benefits. Current studies and indeed schemes (e.g. India) confirm that the former, are usually less costly (but not always begnign) in environmental and social terms while storing more of the available water than a large-scale alternative downstream. However, the local-livelihood enhancements that multiple upper-catchment dams provide may have little impact on national or regional self-sufficiency because of lower physical and social connectivity with the economy as a whole.

The viability of each of these levels of physical interventions depends on current levels of development and their effectiveness and on local demand opportunities and cultural preferences in terms of labour and cooperation around shared natural resources. Although this paper is more concerned with local demand opportunities, the importance of local cultures and practices means that non-physical interventions cannot be ignored. Other components of the Collaborative Programme (CP) are addressing these related themes.

### Non-physical interventions

As far as non-physical interventions are concerned, these also fall into four categories. The first is public awareness because experience shows that uninformed rural communities tend not to take good advantage of supply-driven irrigation facilities. Therefore, it is far better to raise awareness of the potential benefits of irrigation and relate these to the skills and resource base of the beneficiary community in the hope that they become empowered to demand irrigation and the associated resource utilization rights (Box 2). Equally, with rights come responsibilities. Unless there is awareness of these responsibilities, particularly in relation to operation, maintenance and the prudent use of natural resources, enthusiastic demand can lead to bitter disappointment, resentment, dilapidated infrastructure and degraded environments. Further, under a well-informed and transparent mode of implementation, it is generally easier to introduce potentially unpopular cost recovery and regulatory measures.

The second category is that of politics and policy. sub-Saharan Africa countries (and their development partners) are realizing that irrigation development, if it is taking place at all, cannot take place in the supply-driven ad hoc fashion that it has in the past. Instead, workable sectoral policies are required that recognize the need for the correct balance between hard and soft interventions. Such policies have to be backed up with investment strategies that: (i) provide decision-making and planning frameworks instead of the "shopping lists" of the past; and (ii) that potential investors of any kind consider enabling.

The third category is the legal framework, which provide the basis for economically efficient allocation of water while also protecting customary use and making access to its productive potential more equitable. This is increasingly likely to involve the adoption of: transparent and stable water-use rights; economic pricing of water; and well-regulated markets in which water use rights can be traded between willing buyer and willing seller at a mutually agreeable price. At the same time, where water user groups are involved, the legal provisions for recognizing their status and liabilities are invoked.

Many of these legal provisions have institutional implications, hence the fourth category, which is that of institutions and service delivery. Many state irrigation sectors are or have been managed by centralized bureaucracies with limited local responsiveness. In many cases, gains can be made by decentralizing the sectoral functions, such that decisions are made as close as possible to those affected by them, functions are subsidiarized and beneficiaries involved to a far greater extent in all stages of their project cycles, including operation and maintenance (O&M). This may require in turn that public-service providers become more commercialized in their approach and performance, or that private-sector entities be allowed to provide the necessary services. The art is to effect such transitions without increasing transaction costs in the long term. The example of the Office du Niger in Mali is a case in point where the use of a tripartite performance contract between farmers, the irrigation agency and government has opened up a policy and investment space that might otherwise have closed down (Aw and Diemer, 2005).

### Financing modalities

Finally, there is the matter of finance, both capital and recurring. While this study assumes that it is desirable to mobilize increased investment in irrigation through the bilateral and multilateral funding agencies, it is helpful to understand that a wide range of financial sources could be involved and in various combinations. Furthermore, each of the potential players will have their own objectives and sometimes hidden agendas.

First, there is commercial capital. This means financial reserves that a commercial entity could use to invest in new, improved or expanded irrigation, some of which may involve small-scale outgrowers. As this does not involve any public money, it is a desirable way to finance irrigation development. However, it is acknowledged that despite its potential for poverty alleviation by providing direct and indirect livelihoods, commercial irrigation may not be relevant to self-sufficiency and only indirectly relevant to macrolevel food security. Notwithstanding the desirability of commercial investment, many potential commercial investors may not be convinced that such investments are particularly attractive where poor governance is an issue. Consequently, governments that wish to see more commercial investments need to provide acceptable enabling environments. In addition, although much of the enabling environment comprises non-physical elements, such as financial regulation and reliable markets, there may also be physical public goods, such as new or improved rural access and transport facilities, without which an investment in irrigation would be meaningless.

Next are commercial credits. These are funds that can be borrowed from merchant and clearing banks as well as specialist institutions, such as banks for agriculture, insurance companies, central estates and equipment suppliers. Mobilization of such credits often requires collateral in a form that is meaningful to the lender. This can be difficult for many poor small-scale farmers, especially where land tenure is unclear. Various methods have been used to solve this problem including social collateral and loan underwriting by a bilateral donor. Key issues also include affordability, usually in terms of interest rates, but sometimes in terms of commitment fees and modality (i.e. seasonal loans having to be used to finance longer-term farming systems shifts or banks having stop orders on a farmer's production rendering the farmer little more than a labourer for the bank). There is also the issue of financiers' involvement in the farmers' day-to-day business.

The State itself is an obvious source of finance. However, such finance is usually scarce in relation to the wide range of demands upon it. Inordinate state establishment costs can sometimes be trimmed by institutional downsizing. Equally, better enforcement and expansion of tax systems may increase the ability of a government to invest. Even so, most state funding comes in the form of counterpart funding of programmes mainly funded by a country's development partners, or in so-called public/private partnerships.

In this context, the term "development partners" is intended to mean international development banks and bilateral donors. These are one of the main targets of this study and, in addition to counterpart funding, usually expect client countries to have made or be making clear progress towards better governance and increased commitment to social equity, gender opportunity and the adoption of sound environmental principles. Furthermore, such agencies prefer to think of themselves as partners with government. They like to identify investment opportunities with the beneficiary governments rather than simply being given a "wish list". In other words, the mantra of participation and consultation is applicable at all levels. This is beginning to result less in traditional sector master plans than in framework investment strategies. However, there are dangers in that: (i) countries can be forced into uncomfortable or even erroneous positions by donor pressure; (ii) monitoring results in unsustainable disbursement rates owing to donor preference for disbursement-based progress; and (iii) there may be policy conflicts between different development partners.

Non-governmental organizations (NGOs) also have a role to play in the financing of public irrigation. However, budgets are usually limited, hence funds are often targeted not at the infrastructure itself but at building grassroots capacity such that the infrastructure is productively utilized. Nonetheless, some NGOs are involved in the supply of low-tech equipment such as International Development Enterprise, which supplies simple driplines and treadle pumps. There are some examples of NGO-funded infrastructure but these are limited and have met with varying degrees of success.

Finally, there are the beneficiaries themselves. Sustainability and ownership concepts are thought to be closely linked, and participation in the financing of a scheme goes a long way towards establishing the levels of ownership required. Financial capacity at the grassroots is usually limited in the extreme, but there are other ways to mobilize resources. One is labour and another is to use food-for-work or even better labour-based construction modalities. The latter approach is particularly interesting as a proportion of the labour wages can be retained by the implementing agency and used to establish an O&M fund for the scheme. In fact, given the benefits of labour-based construction, some development banks (in order to make them more competitive) discount a portion of the financial bids of labour-based contractors bidding against those preferring to remain with mechanical methods. The importance of O&M funding cannot be overstated. For this, the participation of the beneficiaries becomes paramount. They should be fully responsible for all recurring costs at scheme level as well as those incurred in delivering water to the schemes, except perhaps where shared, large-scale bulk infrastructure is concerned – which it may be appropriate to consider as public goods (Riddell, 1998).

## SUMMARY

This discussion of some key physical and non-physical aspects of water development and management in agriculture makes clear that this study is concerned with rather more than a simple alignment of demand (in terms of self-sufficiency) with irrigation development potential. The processes by which irrigation investment is planned and sustained have been indicated. More detailed treatment is available in the companion reports, notably (Morardet, S. *et. al.*, 2005).

Issues relating to demand are complex. In most situations, demand for irrigated production exists. The critical issue for the expansion of irrigation is not whether there is demand for irrigated output, but the impact of increased irrigation on the prices at which irrigated commodities trade. This depends critically on the structure of the market and the extent to which increases in irrigated production can supply the right quantity and quality into that market.

In itself, self-sufficiency is rarely accepted as a viable objective for a country or a group of countries as it prevents the full exploitation of the potential gains from specialization and trade. In addition, self-sufficiency, as normally measured, may mask substantial amounts of seasonal and informal cross-border trade. Notwithstanding these reservations, a set of practical considerations makes it both worthwhile and necessary to examine the demand for sub-Saharan Africa irrigated production in terms of self-sufficiency, at least as a point of departure.

Equally, irrigation development comprises far more than concrete maps that link the available water with the available land. It is not a given that irrigation is the best way to meet demand, nor is increased agricultural production the only route to food security.

However, where irrigation is justified, then it will involve establishing a sustainable mix of physical and non-physical interventions to bring the structure of the irrigated subsector (both public and private operators) into a position where it can adapt to changing market conditions.