RURAL DEVELOPMENT IN MOROCCO:

ALTERNATIVE SCENARIOS TO THE YEAR 2000

by

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EXECUTIVE SUMMARY

Morocco is in the process of formulating a rural development strategy aimed at generating rapid and efficient income growth in rural areas with positive repercussions in the rest of the economy. In this study, an economywide model focused on Morocco's rural economy is used as a laboratory for analyzing issues at the core of such a rural development strategy. The features of the model are summarized in a separate box at the end of this summary. The base-run solutions for 1994 and 2000 are calibrated to replicate simulation results for a basic reform scenario generated by the RMSM (Revised Minimum Standard Model) of the World Bank. This scenario incorporates the implementation of a basic reform program including a smaller government, increased government savings and reduced micro-level price distortions (reduced non-tariff barriers and partial unification of the rates for indirect taxes and import tariffs), paving the way for a higher GDP share allocated to investment. The model is used to explore the effects of alternative scenarios for water tariffs and sales, and supply-side advances (irrigation expansion, and accelerated productivity growth, both in agriculture and other sectors). Among these, instruments of tax policy and irrigation expansion are under the direct control of policymakers whereas other supply-side shifts are less directly influenced by government actions.

In the base scenario, the major macro aggregates closely replicate the World Bank RMSM simulation (including growth in real GDP at an annual rate of 3.1%), involves slower growth in agriculture (especially for cereals-legumes and livestock products) than in other sectors, primarily the result of reduced border protection. While average household per-capita incomes increase by 10% between 1994 and 2000, income growth is slower in rural areas, especially for farm households, who depend on returns from water and land for the bulk of their incomes. These results reinforce the need to develop a strategy for rural development that speeds up rural income growth and generates positive economywide repercussions.

In Morocco, irrigation water is subsidized for farmers in large-scale irrigation (LSI) schemes, covering slightly less than half of the permanently irrigated area. Such subsidies lack social justification (as a group, the farmers who benefit from the subsidy are not less well off than others), and absorb resources that more fruitfully could be allocated to other purposes (for example adding to government savings and/or to government spending in areas of higher social priority). Model simulations confirm that, while the imposition of a higher water tariff has the drawback of hurting LSI farm households, it has the advantage of improving the government's fiscal position. If the water tariff hike is combined with farmer water sales, the impact on these farmers is cushioned while significant quantities of water are liberated for use elsewhere in the economy. In addition to paving the way for a more efficient sectoral allocation of water (inside agriculture and between agriculture and other sectors), such water sales may also encourage water-saving technical change based on investments financed by the farmers themselves.

The national plan for irrigation expansion, including proportional increases in irrigated areas and water supply, has a positive impact on macro indicators and household incomes, especially for the rainfed farm households who own the land that is converted from rainfed to irrigated. However, the program has a negative impact on existing irrigated farm households (who initially control all irrigated land and water resources) since they face declining land and water rents. The benefits of the program may be measured by the increase in real factor incomes that it brings about. Benefit-cost analysis, drawing on this information and separate cost data, suggests that internal rate of return of the program (the discount rate at which the net present value is zero) is around 8-10%, i.e., a fairly moderate rate of return. Whether irrigation expansion should be undertaken or not depends not only on the rate of return for the program; it is also influenced by the returns to competing alternative projects.

Productivity growth is crucial for raising growth in production and incomes. A set of simulations explores the impact of accelerated growth in total factor productivity for different agricultural subsectors, for aggregate sectors (agricultural, rural non-agricultural, and urban), and for the economy as a whole. The effects are uniformly positive, both in terms of macro indicators (including GDP growth and employment generation) and household incomes. The gains are shared widely in the sense that no household group loses in absolute terms. However, in relative terms, urban households gain the most because they derive the bulk of their incomes from factors that are intensively used in dynamic sectors facing high income and price elasticities of demand. The only exception to this anti-rural distribution of gains is the case of accelerated productivity growth for non-agricultural rural activities, primarily producing non-tradable commodities, where the rural households gain more than their urban counterparts. This distributional effect stems from the fact that these commodities, whose relative prices decline, primarily are demanded by households and producers in rural areas. Given the aims of a rural development strategy, rural non-agriculture is a high-priority area for productivity-raising efforts.

In a final set of simulations, the model is used to explore win-win scenarios that combine elements of the above simulations — more rapid productivity growth in rural (agricultural and non-agricultural) activities, higher water tariffs, and water sales — with improved penetration of export markets for fruits and vegetables. The results demonstrate that, under realistic assumptions, it is possible to design a policy package and resulting development path that combine rapid and efficient growth in incomes and production throughout the economy with an improved relative position for the rural population.

SUMMARY OF MODEL FEATURES

The analysis of this paper uses an economywide agriculture-focused model of Morocco which has been designed for analysis of rural development issues. The model emphasizes agriculture, rural non-agricultural production, and sectors with strong links to agriculture (supplying inputs or processing outputs). The model is closed by an aggregate representation of urban activities, capturing economy-wide issues.

The model has a detailed treatment of agriculture, including 33 activities in crop and livestock production. Activities, which may yield multiple outputs, are disaggregated into irrigated and rainfed, differing in their techniques (yields and mixture of factors and other inputs). The model captures the structure of input-output links in the economy; inside agriculture, this includes links between crop and livestock production (for example the use of manure as input in crop production).

The factors of production are divided into capital, labor (urban and rural), and agricultural resources (rainfed land, irrigated land, water, and pasture land). Producers maximize profits subject to production functions with neoclassical substitutability for factors and fixed coefficients for most intermediate inputs. Households (a total of five groups, including three in agriculture — irrigated and rainfed farmers, and rural workers) receive the bulk of their incomes from the factors they control, including worker remittances from abroad, and use their income to save and consume (according to demand functions derived from utility maximization).

Flexible prices clear most markets; the main exception is labor for which unemployment at a fixed real wage is possible. Given the medium-run time frame of the analysis, both capital and labor can migrate between sectors and rural-urban areas. Outputs that are sold domestically and traded internationally are imperfect substitutes. The same assumption is made for agricultural outputs from irrigated and rainfed zones. The macro rules of the model are simple: government savings is a residual; a flexible real exchange rate equilibrates the fixed current account deficit; and adjustments in the urban household savings rate assure that aggregate investment, a fixed share of GDP, is fully financed.

The model, which is solved in a comparative static mode, provides a simulation laboratory for doing controlled experiments, changing policies and other exogenous conditions, and measuring the impact of these changes. Each solution provides a full set of economic indicators, including household incomes; prices, supplies and demands for factors and commodities (including foreign trade for the latter); and macroeconomic data.

1. INTRODUCTION[1]

Morocco is in the process of formulating a rural development strategy aimed at accelerated growth and poverty alleviation in the context of a transition toward a more open and liberal economy. For the agricultural sector, this involves, inter alia, using taxes, subsidies, and other policy tools with the aim of raising the efficiency of resource utilization, supporting productivity-raising investments, and generating higher incomes from employment and other sources.

The model of this paper, which is disaggregated so as to capture key aspects of the economic structure of rural Morocco, provides a laboratory for doing controlled experiments, changing policies and other exogenous conditions, and measuring the impact of these changes. It is here used to analyze issues related to water tariffs and agricultural water sales to urban households, irrigation expansion, and productivity growth (both in agriculture and other sectors). We start with an overview of the model structure and the data base (Section 2). Section 3 presents the simulations and analyzes the results; Section 4 synthesizes the main conclusions. The paper includes an appendix presenting tables with supplementary simulation results and other data underlying the analysis.

[1]The authors would like to thank Moataz el-Said for invaluable research assistance. We are grateful to staff at MAMVA and participants in World Bank seminars for comments and help with data. They have all contributed to the strengthening of this research. The responsibility for remaining shortcomings are those of the authors.

2. MODEL STRUCTURE AND DATA SOURCES

We will here present the rural-economy model and its data sources. The current model, which draws on existing economy-wide models of Morocco, is distinguished by a detailed treatment of agriculture, which is disaggregated into rainfed and irrigated areas.[2] As opposed to previous models, it is solved as a mixed-complementarity problem; this permits excess supplies (unemployment) of agricultural resources and labor, an important feature rarely found in economywide models (but common in agricultural sector models). Outside agriculture, the treatment is more detailed for sectors with strong links to agriculture or rural households. To avoid the fallacy of viewing the rural economy as an isolated island, the model is closed by adding an aggregate representation of urban activities. The latter addition is extremely important since rural households and activities, though linkages via output supplies, consumption and input demands, and labor migration, both influence and are influenced by changes in the urban economy. The following presentation of model is divided into four sections, covering its structure (its treatment of factors, activities and commodities, and institutions) and data sources.

2.1. FACTORS

Table 2.1.1 shows the disaggregation of factors, institutions, activities, and inputs. The model includes ten factor types, eight of which are rural. In terms of the broader categories, labor and capital are used by all activities whereas resources are only used by agriculture. Given the medium-term time frame of the analysis, it is also assumed that each capital type is freely mobile across sectors. Each resource is allocated across the

[2]The rich tradition of economywide models of Morocco is exemplified by Mateus *et al.* (1988), Morrisson (1991), Rutherford *et al.* (1993), Serghini (1993), Roland-Holst and van der Mensbrugghe (1994), and Goldin and Roland-Holst (1995).

activities demanding it — irrigated crop activities for irrigated land and water; rainfed crop activities for rainfed land; and livestock activities for pasture — so as to equate its marginal value in each activity with the rent. For all resources except water, full utilization and a flexible market-clearing rent is assumed. For water, the option of excess supply in combination with a zero rent has been added.[3]

The treatment of rural and urban labor captures the phenomena of migration, sectoral wage differences, (potential) unemployment, and downward wage rigidity. Wages are differentiated across the demanding sectors on the basis of fixed ratios (calculated from base-year data); the wage differences are a reflection of existing distortions and other real-world phenomena whose causes are not modeled explicitly. Workers (but not the households to which the workers belong) are freely mobile, not only within each region, but also, via migration, between rural and urban regions. In the rural labor market, full employment and a flexible average wage are assumed. In the urban labor market, the average wage is fixed at a minimum level if there is less than full employment; if full employment is reached, the wage is flexible upwards.[4] Labor migration (in either direction) assures that the ratio between the average rural and urban wages is fixed.

In practice, this labor market treatment means that, if urban employment is less than full, urban and rural wages are fixed. In this case, upward pressure on the rural wage produces urban-to-rural migration; downward pressure on the rural wage produces rural-to-urban migration. If urban employment is at the full employment level, both urban and rural wages are flexible; migration will assure that the ratio between the averages remains unchanged. The resulting relatively high degree of mobility in the labor market is

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[3]For water, this is the part of the rent kept by the farmers. In addition, there is a fixed (subsidized) charge per unit of water used.

[4]Full employment is defined as a 5% unemployment rate.

appropriate given the medium-term perspective of this paper — adjustments are assumed to take place during a six-year period.

2.2. ACTIVITIES AND COMMODITIES

The model covers 42 production activities, including 33 in agriculture (cf. Table 2.1.1). The criteria used for determining whether a crop activity is singled out are area share (crops occupying more than 5% in the relevant region are included) and policy relevance: is the crop directly affected by a specific policy intervention? The model also covers the main livestock activities. In order to capture multiplier effects inside the rural economy (not only consisting of agriculture), a rural service sector has been distinguished; its non-tradable output is sold to agricultural activities, rural households, and as an intermediate input to the rural service sector itself. Other sectors with strong links to agriculture have been singled out: fertilizers/pesticides and energy (for backward linkages, as well as food processing and sugar processing (for forward linkages). A public administration activity, which is highly labor intensive and financed by the government, is included to permit the simulation of the policy lever of public sector employment. Finally, the model is closed by adding one aggregate urban sector representing the rest of the economy.

Outside the agricultural sector, the commodity disaggregation is very closely linked to the activity disaggregation since most activities yield only one output. Inside agriculture, however, most activities yield multiple outputs, for crops typically a major product (for example grain) and a byproduct used as animal feed. For livestock activities, the most important outputs are meat, milk, and manure. The outputs of activities that appear in more than one region (for example soft wheat and vegetables), are assumed to be imperfect substitutes. Agricultural input demands are aggregated to match the commodity categories in the rest of the model.

2.3. PRODUCER BEHAVIOR AND TECHNOLOGY

Table 2.3.1 summarizes basic model assumptions. Producers in all activities maximize profits subject to their technologies. For all sectors, the technology is specified by a nested neoclassical (Constant-Elasticity-of-Substitution or CES) value-added function (with the relevant factors as arguments), and fixed (Leontief) intermediate input coefficients. There are some exceptions to the assumption of fixed intermediated input coefficients: for livestock, (food and sugar) processing, and vegetable activities, these coefficients are flexible for selected inputs in the context of producer minimization of input costs subject to a limited degree of substitutability between different inputs (given by a CES function) and a fixed *aggregate* input requirement per unit of each activity. The purpose behind this formulation is to permit more flexibility in terms of input mix as relative prices of inputs from agriculture change.[5]

2.4. INSTITUTIONS

On the institutional side, the model includes households, government, and the rest of the world. Domestic factor incomes are split among the domestic institutions in fixed shares. The disaggregation of households closely follows the factor disaggregation, i.e., the households are largely extensions of the functional factor distribution.

In addition to factor (capital) incomes, government revenue consists of indirect domestic taxes, tariffs, and transfers from the households. All taxes are *ad valorem* whereas household transfers are expressed as fixed income shares. The government

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[5]With fixed input coefficients, livestock production in rainfed areas would, unrealistically, be in direct proportion to the area of pastureland. Similarly, vegetable activities would be rigidly linked to the availability of manure, an input they use intensively.

allocates this income to transfers to households (a fixed share of GDP) and the rest of the world (fixed in foreign currency), consumption (also a fixed GDP share), *ad valorem* subsidies, and savings.

Among households, farmers receive the bulk of their incomes from agricultural resources, crop capital, and rural labor. The fact that, if water is scarce, its income (like land incomes) accrues to the irrigated farm households, is compatible with the assumption that proprietary rights to water have been assigned to the current users.[6] The rural worker households live off labor incomes while the incomes of the other rural households primarily come from capital. The incomes of the urban households are mainly from capital and labor. Factor incomes are complemented by transfers from the government and the rest of the world (fixed in foreign currency). On the spending side, household incomes are used for savings (according to exogenous saving propensities for all but one; cf. later discussion of rules for achieving balance between savings and investment) and consumption. Consumption demands (in per-capita form) are derived from maximization of a standard neoclassical utility function.[7]

The rest of the world supplies imports and demands exports. Given Morocco's small foreign market shares, import and export prices are exogenous in foreign currency (i.e., import supply and export demands are infinitely elastic at given prices). Domestic prices of commodities and domestic outputs and all flexible, varying to clear relevant markets in a competitive setting where both suppliers and demanders are price-takers. The prices include relevant policy wedges such as tariffs and subsidies.

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[6]Basic issues related to tradable water rights are discussed in Rosegrant and Binswanger (1994). Rosegrant and Gazmuri (1995) draw lessons for developing countries from case studies of tradable water rights in Chile, Mexico and California.

[7]The model uses the Stone-Geary utility function, which yields a set of LES (Linear Expenditure System) functions. For details, see Dervis *et al*. (1982, pp. 482-485).

For any commodity, it is assumed that there are quality differences between exports, imports, and domestic output sold domestically, as well as between the outputs of different domestic activities (to the extent that more than one activity exists in the sector — this only applies to a subset of the agricultural activities, for example vegetables produced both in the irrigated and rainfed sectors).[8] The assumption of quality differences is crucial: it grants the domestic price system a degree of independence from international prices, permits regional (irrigated vs. rainfed) price differences, and dampens foreign trade and domestic production responses to changes in the producer environment.

More technically, the Armington assumption is used to model the choice between imports and domestic output. This means that, to the extent that a commodity is imported, all domestic demands are for a composite commodity made up of imports and domestic output, with the mix between the two determined by the assumption that domestic demanders minimize cost subject to imperfect substitutability, captured by a CES aggregation function. The same functional form is also used to model imperfect substitutability between different domestic suppliers of the same commodity; this treatment is relevant for several agricultural commodities. For exported commodities, the allocation of domestic output between exports and domestic sales is determined on the assumption that domestic producers maximize profits subject to imperfect transformability between these two alternatives, expressed by a Constant-Elasticity-of-Transformation (CET) function.

The macro system constraints (or macro closures) determine the manner in which the accounts for the government, the rest of the world, and savings-investment are brought into balance. Government savings is the flexible residual that clears the government account; i.e., the rules for government spending and revenue collection are

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[8]Compared to multimarket and agricultural sector programming models, which assume perfect substitutability for all outputs, the inclusion of the option of imperfect substitutability is an improvement, associated with the CGE literature.

not adjusted to generate a predetermined level of government savings. For the rest-of-the-world account, an endogenous exchange rate validates a current account deficit (foreign savings), that is fixed in foreign currency; to avoid a deficit that is larger (smaller) than the fixed level, the exchange rate will depreciate (appreciate). On the spending side of the savings-investment balance, investment demand is a fixed GDP share; this amounts to assuming either that investment decisions are invariant to the simulations that are carried out or, alternatively, that the government uses policy instruments (including public-sector investments) to generate the target investment level. On the savings side, the urban household savings rate is flexible, varying to generate the level of total savings that is needed to finance aggregate investment.[9]

2.5. DATA SOURCES AND APPROACH TO MODEL SOLUTION

The data base draws on (i) disaggregated agricultural information from the Moroccan government, the World Bank, and the FAO, primarily for 1990/91;[10] (ii) a disaggregated economywide framework represented by Social Accounting Matrices (SAMs) for 1990 and 1994, an input-output table for 1990, as well as data on the 1994 policy regime — taxes, subsidies, and non-tariff barriers (Bussolo and Roland-Holst, 1993; Roland-Holst, 1996a); and (iii) 1994 macro data from the World Bank RMSM (Revised Minimum Standard Model) (Soman, 1996). An adjusted version of the RAS-

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[9]Savings from the other sources —government, other households, and the rest of the world— are not free to equilibrate aggregate savings-investment: government and rest-of-the-world savings perform the task of clearing their respective balances while the savings rates for other households are a fixed share of income.

[10]The Moroccan government sources include MAMVA (DPAE/Division des Statistiques and DPV, AGER, DPA, and ORMVA), Ministère des Incitations à l'Economie (Direction de la Statistique), Ministère des Finances, Ministère de l'Industrie, Ministère des Travaux Publics, and Caisse de Compensation.

Entropy program for SAM balancing was used to generate a disaggregated SAM for 1994 that replicates observed aggregates for the agricultural sector and on the macro level (see Golan *et al*., 1994) and incorporates the disaggregation of factors, institutions, activities, and commodities that is required for the current model structure. A macro version of this SAM is displayed as Table 2.5.1.

Most model parameters are derived from this SAM. Elasticities for the functions used — Armington, CET, CES (for production), and LES (linear expenditure system; for household demand) — are based on data available from other studies on Morocco (Aloui *et al,.* 1989; de Janvry *et al*., 1992; Goldin and Roland-Holst, 1995; Laraki, 1989, Mateus *et al.,*1988; Morrisson, 1991; and Rutherford *et al.,* 1993).

The current model is solved as a mixed-complementarity problem (MCP), consisting of a set of simultaneous equations that are a mix of strict equalities and inequalities but without an objective function. This approach, made feasible by the recent development of solvers, makes it possible to formulate a model that combines desired features of mathematical programming models (in particular by permitting excess supplies of agricultural resources, such as water) while permitting the full range of assumptions for consumer demand, government policies, and foreign trade that appear in multimarket and CGE models. The GAMS modeling software is used both to generate the database and to implement the model. The model is solved with PATH and MILES, two solvers for mixed complementarity problems.[11]

[11]For GAMS, see Brooke *et al.* (1988). Rutherford (1995) provides more information on PATH and MILES. The agriculture-focused CGE model of Egypt in Löfgren *et al.* (1996) is solved as an MCP problem.

3. SIMULATIONS

3.1. BASE

The model was initially solved for 1994 and 2000; for the latter year, the results capture the outcome of a reform scenario according to the RMSM (Revised Minimum Standard Model) of the World Bank (Soman, 1996). The projected path assumes the implementation of a basic reform program including a smaller government, increased government savings and reduced micro-level price distortions, paving the way for a higher GDP share allocated to investment and creating a more open economy with exports and imports representing larger GDP shares. On the micro-level, the rates of non-tariff barriers are cut in half and indirect taxes and import tariffs are partially unified: for each tax and tariff rate, half of the gap between its 1994 level and the corresponding 1994 average rate was removed. (The rates are displayed in Tables A.6-8.)[12]

Macro results for 1994 and 2000 with the RMSM and our model are displayed in Table 3.1.1. As shown, our model closely replicates the RMSM results. Total factor productivity (TFP) was calibrated to generate the target level of real GDP.[13] For investment, government spending and revenue items, parameter values were specified so as to bring the simulated results very close to the RMSM path. In the labor market, however, endogenous adjustments generated a decline in urban unemployment to 16.9% instead of remaining around 20% according to the RMSM.

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[12]The Appendix includes disaggregated simulation data on foreign trade, resource allocation, GDP growth, and policy parameters for 1994 and 2000 (rates for import tariffs, non-tariff barriers, and indirect taxes).

[13]The rate of TFP growth was slightly negative, -0.41% per year, a plausible number given a moderate GDP growth rate and large annual variations, driven by a severe drought in the beginning of the simulated period.

Table 3.1.2 shows additional information for the 1994 and 2000 model solutions. Aggregate GDP at market prices grows at an annual rate of 3.1% Agriculture (both the irrigated and rainfed subsectors) grows more slowly than other parts of the economy as a result of the policy changes, significantly reducing tariff and non-tariff protection for agriculture, especially for wheat, livestock and sugar sectors, with a strong negative impact on sectors with large trade shares.[14] This leads to negative growth for cereals-legumes (especially in irrigated areas where soft wheat dominates) and livestock production (with a more strong decline for irrigated areas due to the small role of the non-traded sheep-goat sector). Vegetable and fruit production (more important in irrigated agriculture) grows rapidly in both irrigated and rainfed areas as resources are reallocated in their favor.

On the factor level, income growth is slow for the major immobile agricultural factors (water, and irrigated and rainfed land). Due to its strong link to the sheep-goat sector, the return to pasture land grows at a more rapid pace. On average, per-capita household incomes go up by 10% between 1994 and 2000. However, incomes are stagnant for farm households (who depend strongly on land and water incomes) while more rapid growth is enjoyed by other households, both urban and rural, whose incomes stem from mobile capital and labor. A depreciation of the real (CPI-indexed) exchange rate is required to maintain the fixed trade deficit as border protection is reduced.

The BASE simulation shows that average income growth is slower in rural areas where incomes initially are lower than elsewhere. Against this background, the following

[14]Soft-wheat and sun-flower activities shrink drastically (by 10-15% per year), while all sugar activities (irrigated and rainfed sugar beet, irrigated sugar cane, and sugar processing) decline at a more moderate pace (2-3% per year). Growth in the other animal activity (including poultry) is stronger, among other things because of a much smaller trade share.

simulations examine a strategy aimed at speeding up rural income growth. They cover exogenous changes in three areas: water (tariffs and sales to urban areas), irrigation expansion, and accelerated productivity growth. To the extent that these changes require additional government resources, it is assumed that the cost either is part of projected government spending or can be covered by reallocating government resources from unproductive uses without any broader economic effects. For the simulations that follow, the results for the BASE scenario provide the benchmark for comparisons.

3.2. WATER: TARIFFS AND SALES TO URBAN AREAS

In Morocco, the provision of irrigation water is subsidized for farmers in areas belonging to large-scale irrigation (LSI) schemes operated by ORMVAs,[15] representing around 47% of the area under permanent irrigation and 7% of the total cultivated area (see Table A.11 for disaggregated data on cultivated areas). Such subsidies lack social justification (as a group, farmers in large-scale irrigation schemes are not less well of than others), and absorb resources that more fruitfully could be allocated to other purposes (for example adding to government savings and domestic investment and/or to government spending in areas of higher social priority). The subsidy may be defined as the difference between the charge (per m^3) required for full-cost recovery and the average farmer water charge. Our data (see Table A.9) indicate that, in 1994, the government recovered around 0.065 Dh. per m^3 of water used in LSI areas, corresponding to around 28% of the costs of O&M (Operations and Maintenance, also including energy) and 19% of a more complete water delivery cost, also including amortization.

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[15]ORMVAs (Offices Régionaux de Mise en Valeur Agricole) are regional agricultural development authorities in charge of part of the country's irrigated areas (large-scale schemes and others) and adjacent rainfed lands.

The content of the water-tariff simulations and their effects are summarized in Tables 3.2.1-2. In the first simulation, TAR-OM, the government water tariff is raised to the level of 1994 O&M costs while, in TAR-FC, it covers the full delivery cost. The repercussions of these two tariff hikes are qualitatively similar. Tariff increases lead to a decline in average irrigated farmer incomes (by 4-7%), and an increase in government savings, with a corresponding decline in household savings as the urban households shift part of their income from savings to consumption. The decline in the income of the average irrigated farm household would be limited to farmers in LSI areas; for this group, the increase in tariffs generates an income cut of 8-14%.[16]

Except for the change in irrigated farmer incomes, the repercussions are quite moderate — the macro significance of increased cost recovery is small. On the micro level, the total water rent (the marginal value product of water) is not affected; the tariff increase merely leads to a reallocation of water rent from farmers to government. The fact that total water consumption is unaffected reflects that, also after the tariff hike, the tariff is less than the total rent, leaving a positive residual rent to the farmers whose optimal water allocation and total water consumption are not affected.[17]

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[16]This calculation assumes that the representative farmer under LSI only differs from the average farmer in the rest of the irrigated areas in that he pays water tariffs.

[17]This lack of response may also be explained as follows: The representative irrigated farmer is entitled to a given water quantity. Given that the value of the last drip (the marginal value product of water) exceeds the initial unit water tariff (leaving a positive marginal return to the farmer), the farmer fully uses this water quantity, allocating it across crops so as to maximize profits. If after a hike, the unit tariff still falls short of the marginal value product of water, there is no direct production response — the farmer still maximizes profits by allocating the full quantity across the crops in an unchanged manner. The only change is that the unit tariff is larger and income is reallocated from the farmer to the government. In reality, it is likely that these conditions hold for the average tariff-paying LSI farmer; also after the hikes, he would be left with a positive marginal return to their water.

The indirect effects of the resulting changes in the pattern of incomes and spending generate a negligible (but unfavorable) impact on GDP growth and sectoral production volumes, unemployment, and aggregate household income. These changes are driven by the initial redistribution of water income (from irrigated farmers to the government), reallocating consumption demand from the commodity bundle demanded by irrigated farmers (who have less income available for consumption) to the bundle desired by urban households (who save less and consume more as government savings expand).

While these results provide a reasonable approximation of the major real-world impact of the proposed tariff hikes, it should be noted that marginal farm-level adjustments are likely: the higher tariffs would exceed the water rent of some LSI farmers (in reality water rents are not uniform) who both have the ability and incentive to respond by using less water and/or reallocating water toward crops with higher marginal water returns. Significant changes in the pattern of water use would require structural changes in the system for water allocation (including rules for allocating water across basins).

The absence of an integrated national market for water, by no means unique to Morocco, leads to inefficient water allocation, manifested in large gaps in marginal water values between different users. One step toward reducing this inefficiency would involve giving farmers (both in LSI schemes and other irrigated areas) tradable rights in the water quantities they customarily consume, providing them with the opportunity of selling water to urban and other non-agricultural consumers. Both water sales and higher rates of cost recovery for the irrigation system would be facilitated by farmer participation in water management via Water Users' Associations.

The price at which farmers would be able to sell such a water quantity is difficult to predict; it would fall somewhere between the current marginal return to water received by the farmers (around Dh 0.45 in year 2000 according to the model) and the marginal willingness to pay for urban and municipal users, which may be more than triple this level (World Bank, 1995, p. 23). To illustrate the range of potential gains, two simulations are conducted with the farmers selling 5% of their water.[18] For the first, TAR-SAL1, the price is set at the minimum level, the marginal water return received by the farmers; for the second, TAR-SAL2, the price is set at three times this level.

This sales quantity amounts to a cut in agriculture's water consumption from 85% of total water use (World Bank, 1995, p. iii) to 80.8%, i.e., a major increase in non-agricultural consumption (by 28%, from 15% to 19.2% of the total water supply).

Compared to TAR-OM, these two simulation lead to an increase in the marginal value of the water that remains in agriculture, a less severe fall in the incomes of the LSI farmers, a slight decline in government revenue and savings (since the farmers now pay the water tariff on a smaller quantity), and more widespread (but still small) changes in the cropping pattern, sufficient to generate the required 5% consumption cut; the repercussions are stronger for TAR-SAL2, the simulation with the higher sales price for water.[19] The impact on real GDP is slightly more negative since one productive sector now has to do with fewer resources.[20]

To summarize, the imposition of a higher water tariff has the advantage of improving the government's fiscal position. However, they have the drawback of hurting LSI farmers. Hence, they should only be one of several measures included in a broader and more positive policy package for rural development. If the water tariff hike is combined with the option of selling water, the impact on irrigated farmers is cushioned while significant quantities of water are diverted for non-agricultural use and the economy-wide efficiency of water allocation is improved. Such water sales may increase

[18]The rationale for the choice of 5% is that, within the time frame of this analysis, such a sales share seemed plausible.

[19]The outcome is influenced by the elasticity of substitution between water and other factors of production, set at 1.05.

[20]The model is not structured to recognize the welfare-enhancement that results from higher non-agricultural water consumption.

over time as they provide incentives for water-saving technical change, with an important role for farmer-financed investments.

3.3. IRRIGATION EXPANSION

Expansion of irrigated areas is an important part of government agricultural policies. The simulations in this paper are defined on the basis of “Plan National d’Irrigation” (PNI) for 1993-2000. The projected increase (by 93,400 ha) corresponds to an 8.9% addition to the existing area under permanent irrigation and a 1.5% loss in the rainfed area. Detailed information on the PNI is presented in Table A.10. In the simulations, it is assumed that the land that is transferred from rainfed to irrigated conditions takes on the characteristics of the average piece of previously irrigated land. According to the plan, the increase in irrigated area is accompanied by a corresponding proportional increase in the irrigated water supply, leaving the irrigated farmers with an unchanged quantity of water per hectare.[21]

The plan is simulated first without (IRR-LND) and then with the planned increase in water (IRR-LW); see Tables 3.3.1-2 for assumptions and results. The first simulation is motivated by the fact that the mobilization of water cannot be taken for granted since, among other things, it depends on the amount of rainfall. According to the definitions used for household categories, the "irrigated farm households" keep an unchanged area of irrigated land. The "rainfed farm households" end up owning the rainfed land that stays rainfed as well as the rainfed land that becomes irrigated. The water shares of the two households correspond to their irrigated land shares.

For these simulations there is initially a change in the supply of two or more factors (an increase in irrigated land and a decrease in rainfed land for the IRR-LND scenario,

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[21]A comparison between planned area and water expansion shows that the plan aims at unchanged water quantities per land unit.

combined with an increase in water in the IRR-LW scenario) that generates disequilibrium and price changes in the relevant factor markets. As a result, marginal revenue no longer equals marginal cost in crop activities; the producers respond by changing their output and factor mix, increasing their production of crops that are intensive users of water and irrigated land while marginally contracting their production of crops using rainfed land. These initial responses bring about further changes in commodity and factor prices, household incomes, exports, imports, and the exchange rate before a new equilibrium is reached.

For the first scenario, IRR-LND, the final outcome is a decline in the price (rent) of irrigated land (its supply increased) combined with price increases for rainfed land (supply decrease) and water (in unchanged supply but used jointly with the factor in increased supply). In terms of factor incomes, the combined effects of these price and quantity changes are increases for water and irrigated land but a small decline for rainfed land. This result suggests that output demands faced by the irrigated subsector are sufficiently elastic to absorb additional output without significant price falls while, in the context of a resource transfer to a competing sector, the increase in the rainfed land rent falls short of compensating for the decline in supply.[22] As expected, GDP growth accelerates for irrigated agriculture while rainfed areas produce less. In irrigated agriculture, increased area shares are allocated to cereals and legumes, a reflection of the fact that rainfed zones, the total area of which declines, devote large land shares to these crops. There are insignificant changes in more aggregate indicators — agricultural and economywide GDP at factor cost, economywide GDP at market prices, the rate of unemployment, and average household income per capita.

[22]The demand for output from the irrigated sector may be defined as the difference between national demand and the supply from rainfed areas. As a result of increased resource scarcity and downward pressure on output prices when irrigated production expands, production in the rainfed areas fall, adding to the increase in demand for irrigated output.

On the disaggregated household level, the major effects are lower incomes for the irrigated farm households (reflecting that the declining return to an unchanged quantity of irrigated land and the loss in irrigation water overwhelm the effect of a higher water value) and higher incomes for the rainfed farm households (the total income from the new resource bundle, including irrigated land and accompanying water, exceeds that of the old bundle with rainfed land). The rainfed farmers may be disaggregated into two groups, those who have their land converted to irrigation (occupying 1.5% of the initial rainfed land area) and those whose land remains rainfed (98.5% of the initial rainfed land area), assuming that the two groups are identical in all other respects. As expected, behind the increase in aggregate per-capita incomes by 1.8% lies highly disparate income improvements for the two groups. For the smaller group, whose land is converted, per-capita incomes go up by 23.2% whereas the larger group that remains rainfed only enjoys an increase by 0.8%. The impact on non-farm households is negligible.

For IRR-LW, the land transfer is combined with a water increase. As the economy's resources have increased, growth on the aggregate and agricultural sector levels is more rapid, unemployment declines, and average household income increases. Compared to the outcome for IRR-LND, growth is more rapid for every sector except rainfed agriculture, for which growth declines marginally. Both new and original irrigated farmers benefit directly from the increase in water supplies while other groups benefit from general economic expansion and reduced relative prices of agricultural outputs. All households see their incomes improve compared to IRR-LND and, with the exception of the original irrigated farmers, also compared to the BASE. For disaggregated rainfed farmers, the pattern from the preceding simulation is repeated; the growth rates in per-capita incomes for the beneficiaries of irrigation expansion and for those who remain dependent on rain are 24.9% and 0.8%, respectively.

The impact of irrigation expansion, represented by the IRR-LW scenario, is next assessed in the framework of benefit-cost analysis.[23] Table 3.3.3. shows area expansion, costs and benefits. In Table 3.3.4, the corresponding present values are computed and compared. Two cost alternatives are included, with and without additional O&M costs.[24] (See bottom of Tables for additional explanations). The benefits of the program are measured by the increase in economy-wide real factor incomes (nominal factor incomes deflated by the aggregate CPI), from 294.14 bn. for the BASE scenario to 295.03 bn., i.e., by 0.89 bn. (in 1994 prices). Benefits and additional O&M costs appear gradually, in proportion to the cumulative share of the total area expansion that has taken place, and disappear gradually during the period 2024-2028 (exactly 30 years after each area/water expansion, following MAMVA practice).

If only investment costs are included, the net present value (NPV) of the irrigation expansion program is positive at a maximum discount rate of 9%. If additional O&M costs are included, the maximum rate falls to 8%, i.e., the precise treatment of O&M costs has little influence on the result.[25] Whether irrigation expansion should be undertaken or not does not only depend on how these internal rates of return (8-10%) compare to some

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[23]For the IRR-LND scenario, without additional water, the simulated net return would be strongly negative.

[24]The unit O&M cost for additional water is the difference between what is charged in the model (0.031 Dh/m3) and the 1994 full O&M cost (0.229 Dh/m3). The economic O&M cost (more appropriate for cost-benefit analysis) may be lower than this financial cost to the extent that the financial price of labor exceeds the economic price (likely in a setting with unemployment).

[25]The sensitivity of results to alternative cost assumptions was also explored. A 20% cut in investment costs in each year led to internal rates of return at 12% and 10% when the cost side included investment costs and both investment and O&M costs, respectively. The impact of assuming that payments after 2001 (not yet scheduled) are spread evenly over 2001 and 2002 (instead of being paid in full in 2001, as otherwise assumed) was negligible; there was no change in the internal rates of return.

minimum acceptable economy-wide rate. If agricultural investment funds are limited, the decision would also influenced by the returns to competing alternative projects for agriculture. Moreover, the analysis captures the impact of the investment package during a non-drought year — there is also a need to consider additional benefits arising from increased stability of irrigated production and incomes.

3.4. ACCELERATED PRODUCTIVITY GROWTH

Instead of augmenting the factors of the sector, growth in agricultural production and incomes can be raised by increased productivity of the factors currently available, an aspect that is explored in the following simulations of accelerated TFP growth. The simulations are divided into three groups according to the sectors that are targeted: (a) the entire irrigated and rainfed subsectors; (b) sets of activities (crops or livestock) in both irrigated and rainfed areas; and (c) aggregate economic sectors (agricultural, rural non-agricultural, urban, and all sectors in the national economy). In all simulations, it is assumed that the targeted activities enjoy an increase in annual total factor productivity (TFP) growth by 1.0% per year, raising TFP growth from -0.4% to 0.6%. For the targeted activities, this means that, with unchanged factor quantities, the quantity of output goes up by 1% per year assuming a 1% increase in intermediate inputs (i.e., there is no change in intermediate input use per unit of output). For agricultural crop activities, this can be restated as an annual increase in yield by 1% (along with identical productivity increases for water and labor) combined with an increase in intermediate input use per unit of fixed land (but unchanged intermediate input use per unit of output). The international record suggests that productivity growth at this higher level is highly feasible.[26]

[26]In high-income countries, where TFP growth tends to follow advances in best practice, a typical annual economy-wide TFP growth rate is around 1.5%. In low- and middle-income countries, where TFP growth reflects stronger elements of catching up or falling behind, annual economy-wide growth varies much more widely, between more

Other things being equal, an increase in TFP leads to that marginal revenue exceeds marginal cost in the targeted sectors. In response, the (profit-maximizing) producers increase production, bringing about a chain of repercussions affecting the domestic economy and its interaction with the rest of the world. The distribution of gains from productivity growth cannot be ascertained a priori in an economy which, as in the case of Morocco (and our model), is situated between the two textbook extremes of autarchy and a fully open small economy.[27] For the case of autarchy, if the demands faced by the targeted sector are inelastic (elastic), productivity gains tend to reduce (increase) the incomes of the owners of factors used intensely in this sector. In a fully open small economy, the targeted factors invariably earn higher returns since output prices are not affected (cf. Binswanger, 1980, pp. 201-203). For our model, the middle ground of imperfect integration is captured by the assumption of quality differences between commodities of different origins (domestic or foreign) and destinations (sold at home or abroad).

Tables 3.4.1-2 summarize the assumptions and the results for the first group of simulations. In both simulations, growth increases strongly in the targeted subsector but remains stagnant in the rest of agriculture. Economywide growth, employment, and household incomes (both average and disaggregated) rise in rough proportion to the size of the targeted subsector, i.e., they are much stronger when rainfed agriculture is targeted. On the household level, the owners of the key resources of the targeted sector (one of the

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than 3% per year (for some East Asian countries) and -3% (for countries in sub-Saharan Africa) (World Bank, 1993, pp. 55-56). For the aggregate agricultural sector, the historical record is quite similar, both in terms of growth rates and differences between high- and low-income countries (Ball *et al*, 1996, pp. 39, 50; Pingali and Heisey, 1996, pp. 56-57, 92-93).

[27] As defined here, a fully open small economy is characterized by infinitely elastic foreign demands and supplies for traded commodities, and perfect substitutability between commodities that are exported, imported, and produced and sold in the domestic market.

two farmer groups) gain the most, while the households whose fortunes are linked to the competing subsector (the other group of farm households) gain the least. Other households benefit via the markets for factors and agricultural outputs. However, it should be noted that, when rainfed agriculture is targeted, the gains of rainfed farmers are relatively modest and exceeded by those of some of the consumer households; this reflects that the impact of low elasticities faced by the outputs of the rainfed subsector.

The next set of simulations explores the impact of accelerated productivity growth for groups of agricultural activities, all of which are present in both irrigated and rainfed areas. The simulations and a result summary are found in Tables 3.4.3-4. As expected, the positive economywide effects are most significant when the large cereals-legumes sector is targeted. For all cases, the effects are positive according to both macro and micro indicators, including higher incomes for every household group. Given that household demands are relatively inelastic for cereals and legumes, farm households do less well than others in the first simulation.

The final set of simulations compares the effects of productivity growth for the three aggregate economic sectors — agricultural, rural non-agricultural, and urban activities — as well as the impact of an economy-wide acceleration of productivity growth; given that the targeted sectors are larger, such changes tend to be more difficult to achieve. Data on these simulations are given in Tables 3.4.5-6. The changes in GDP, employment, and average incomes show that productivity growth is a key to improved overall living standards. In the last two simulations, when the urban activities (the largest sector) and the economy as a whole benefit from growth acceleration, the economy reaches full employment and their is some upward wage movement.

However, with one exception, the outcome is more favorable for the urban households than their rural counterparts in general and the farmer households in particular. Ultimately this reflects that, as an economy grows, those who primarily rely on immobile factors in sectors of declining importance tend to suffer compared to others.

The one exception is the simulation PRD-RNAG, where productivity growth accelerates for the rural non-agricultural sector. Since the outputs of this sector are largely non-tradable, substantial gains are passed on to the demanders via lower output prices. In this case, all rural households do better than the urban households. The reason is that, while the links of the urban households are negligible, rural households are strongly linked to the rural non-agricultural sector, both as consumers of final goods and producers purchasing intermediate inputs. Through both channels, a fall in the relative prices of this category of goods raises real agricultural household incomes. Hence, if the goal is to improve the *relative* position of rural households, this sector should be targeted.

3.5. WIN-WIN SCENARIOS FOR RURAL DEVELOPMENT

The preceding simulations have focused on combining a base scenario (including partial removal of price-distorting tariffs and taxes) with exogenous changes in one area. Empirically, it has been shown that, not only are the base-scenario gains for the farm households modest, some of the additional policies that are under way or may be implemented (irrigation expansion and higher water tariffs) would, other things being equal, be detrimental to some or all of today's irrigated farmers. Moreover, for all simulations except the one with increased accelerated rural non-agricultural productivity growth, the gap would increase between average incomes in rural and urban areas.

The approach of introducing exogenous changes in one area helps to sort out the lines of causation. It may, however, divert attention from the fact that successful rural development, generating broad-based income gains throughout the economy and an improved relative position for rural people, requires simultaneous progress on several fronts. Hence, a set of scenarios was formulated to illustrate that such a success can be brought about by relatively modest improvements along multiple dimensions. To illustrate the role of different parts of the strategy, the changes are introduced in a step-wise manner.

The assumptions are presented in Table 3.5.1. The starting point is the scenario with water tariffs fully covering O&M costs (TAR-OM); to facilitate comparisons, this scenario is repeated in the Tables of this section. In an incremental fashion, the following scenarios introduce improved penetration of export markets for Morocco's major agricultural export items, fruits and vegetables (represented by annual growth in foreign-currency export prices by 1%), rural productivity growth (agricultural and non-agricultural, the latter at a more rapid pace), accelerated rural productivity growth, and, finally, sales of agricultural water to urban users.

The results, shown in Table 3.5.2, illustrate that multiple goals can realistically be accomplished at the same time. In the first scenario, WIN-WIN1, higher export prices for fruits and vegetables attract resources to agriculture in general, and fruit and vegetable production in particular. Agricultural output prices and factor incomes increase. Higher agricultural output prices have a negative impact on other sectors and consumers whereas higher factor incomes have a positive effect by raising demand for non-agricultural production. The exchange rate appreciates (to support the trade deficit, fixed in foreign currency). The end result is that, compared to TAR-OM, rural production increases (especially for the fruit and vegetable sectors) while urban production declines slightly. There is no significant change in growth but some decline in unemployment and a minor increase in aggregate household incomes. Farm households benefit significantly, especially in irrigated areas. However, in spite of this improvement, per-capita incomes of households in large-scale irrigation zones remain below the 1994 level. Non-farm households register relatively minor losses. In sum, the assumed increase in fruit and vegetable export prices has positive effects, especially for farmers, but are, on their own, not sufficient to generate a win-win outcome; larger export price increases would benefit some but not everybody.

In WIN-WIN2, rural TFP growth is increased by 0.5% for all agricultural sectors and by 1% for rural non-agriculture; otherwise this scenario is identical to WIN-WIN1. Compared to WIN-WIN1, this pattern of productivity growth leads to a strong increase in aggregate household income, with a bias in favor of rural households including farmers in large-scale irrigation who nevertheless remain worse off than in 1994. (The mechanisms through which TFP growth affects the economy were discussed in Section 3.4.) There are notable increases in production for all sectors and unemployment declines. Increases in incomes and production raise imports and put downward pressure on exports, necessitating depreciation to maintain the exogenous trade deficit. When, in WIN-WIN3, the rates of productivity growth are doubled for agriculture and rural non-agriculture, the changes follow the same pattern and are roughly linear.[28] At this point, all households are better off, also farmers in large-scale irrigation zones.

In the final scenario, all irrigated farmers are permitted to sell 5% of their water at a price set at three times the water rent received by the farmers when using water in crop production. The same assumption was made for TAR-SAL2 and the main effects are similar: there is a strong increase in the incomes of irrigated farm households (by more than 3%) and some decline in irrigated crop production. Otherwise, the impact is small. If the model had been structured to capture the benefits of non-agricultural water consumption, a broad welfare-enhancing effect would have been achieved as water is moved to areas where its marginal return is higher.

To conclude, the last two scenarios demonstrate that a win-win outcome can be brought about by a combination of modest improvements in selected areas. Aggregate performance is stronger than for the BASE according to all indicators. Among agricultural sectors, growth is most rapid for vegetables, fruits and livestock products.

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[28]For example, the annual growth rate for GDP at factor cost increased by 0.44% between WIN-WIN2 and WIN-WIN1; between WIN-WIN3 and WIN-WIN2, the corresponding increase is 0.40%.

The rural non-agricultural sectors grow at a slightly faster pace than agriculture. Improvements in household incomes are widely shared and unemployment declines significantly. On average, the rural households enjoy more rapid income growth than the urban households. In spite of the burden of higher water tariffs, the farm households in LSI zones do significantly better than for the BASE scenario (or compared to 1994). In addition, the proposed scenario strengthens the government's fiscal position, provides significant quantities of water for use elsewhere in the economy, and puts in place an incentive structure that supports water-saving technical change.

4. CONCLUSIONS

This paper presents an economywide model that focuses on the rural economy, with the agricultural sector disaggregated into irrigated and rainfed areas. An aggregate representation of the urban economy is included to capture economy-wide interactions. The model is used to explore issues pertinent to the formulation of a Moroccan rural development strategy: policies for water tariffs and agricultural water sales, irrigation expansion, and productivity growth.

According to the BASE scenario, real GDP grows at an annual rate of 3.1% between 1994 and 2000 and, on average, household per-capita incomes increase by 10% during the period as a whole. However, a disproportionate part of the gains fall in the hands of urban households. Hence, there is a need for a rural development strategy aimed at raising income growth in rural areas.

The results show that, while improving the fiscal position of the government, rasing water tariffs sufficiently to recover O&M costs has a strong negative impact on the incomes of farmers in LSI areas. However, if the option of allowing irrigated farmers to sell water is introduced, the negative impact of the tariff hike is cushioned while significant quantities of water are diverted to other uses. In addition to paving the way for a more efficient sectoral water allocation, water sales may also encourage water-saving technical change based on investments financed by the farmers themselves.

The simulated impact of the national irrigation plan (PNI), including an increase in irrigation water that is proportional to the irrigated land expansion, is positive for all actors except the original irrigated farm households, who face declining land and water rents. However, the gains would be highly concentrated in the hands of the farm households who own the land that is converted to irrigation. Benefit-cost analysis shows that the internal rate of return of the program is modest, in the range of 8-10%.

The simulations suggest that accelerated productivity growth, both economywide and sectoral, is Pareto-improving. However, the relative gains are larger for urban households. The relative incomes for rural households improve only when productivity growth is targeted to rural non-agricultural sectors. Hence, this is a high-priority area for productivity-raising efforts along with the rainfed subsector, the targeting of which is particularly beneficial to the large group of relatively disadvantaged rainfed farmers.

In a final set of simulations, the model is used to explore win-win scenarios that combine elements of the above simulations — more rapid productivity growth in rural (agricultural and non-agricultural) activities, higher water tariffs, and water sales — with improved penetration of export markets for fruits and vegetables. The results demonstrate that, under realistic assumptions, it is possible to design a policy package and resulting development path that combine rapid and efficient growth in incomes and production throughout the economy with an improved relative position for the rural population.

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APPENDIX A:
SUPPLEMENTARY SIMULATION AND MODEL DATA

APPENDIX B:
A NOTE ON MOROCCAN AGRICULTURAL DATA SOURCES DISAGGREGATED BY FARM SIZE

B.1. ACCESSIBLE DATA

B.1. 1. SURVEYS CONDUCTED AT THE NATIONAL LEVEL

The 1981/82 Agricultural Survey by Farm Size (DPAE/MAMVA)

This survey, which is based on a national sample, gives the distribution of land and the cropping pattern by farm size (see Table B.1) but does not give the distribution of irrigated land, the herds, input use, or production levels.

The minimum size of viability survey (Direction de l'Aménagement Foncier)

This survey covered all DPA zones and gives gross margins (agricultural revenue) for small and medium farms. Even though it provides valuable data on small farms, especially revenue levels, this survey has many weaknesses:

- the raw data are not accessible and not centralized;
- the rainfed areas in ORMVAs zones (about 25 % of the cultivated land) are not covered;
- no distinction is made between irrigated and rainfed land;
- lack of homogeneity in the sampling method, in the timing of the surveys (not conducted in the same years) and in the computation procedure of farm revenues;
- large farms are not covered and the sizes of small and medium farms are loosely defined;
- no information are given on the sizes of the herds, inputs uses, nor the level of productivity by activity.

B.1. 2. SURVEYS WITH SMALLER DOMAINS (NOT NATIONAL)

Many studies were conducted at the regional level (local development projects preparation) or as part of academic work (see below list of references). Although these studies include important information on farms, the raw data used are highly heterogenous (various approaches, years, sampling methods, areas of interest, etc.)

Table B.1. The 1981/82 Agricultural Survey (DPAE/MAMVA) (ha)

Crops \ Farm size	0-5	5-20	20-50	50-	Total
Cereals	1041385	1882964	698333	526084	4148766
Legumes	66084	137366	43215	24462	271127
Industrial Crops	32347	33732	7549	19187	92815
Oil Crops	28253	16494	4791	5541	55079
Vegetables	34308	36754	10160	18620	99842
Fodder crops	37825	38197	10919	28680	115621
Others Crops	1748	3189	1356	1310	7603
Fruit Trees	159038	173087	52387	97690	482202
Under trees	70626	55002	32532	8173	166333
Fallow	530650	1261235	532883	500440	2825208
Total area	1860750	3530654	1351827	1208692	7951923
Number of farms	921564	358981	46882	12055	1339482

B.2. DATA NOT EASILY ACCESSIBLE

B.2.1. THE COST OF PRODUCTION SURVEY (DPAE/MAMVA):

According to available information, the DPAE has conducted four "cost of production" surveys (in 1984, 1988 and 1992 at the national level, and in 1989 for a sample of provinces representative of the main bio-climatic systems). These surveys have the advantage of being representative at the national level and contain the necessary information for a disaggregation by farm size (inputs uses and outputs). Unfortunately these surveys were not published and are not accessible.

B.2.2. FARMS BUDGETS AND HOUSEHOLDS LIVING STANDARDS (DPAE/MAMVA)[29]

This survey conducted in 1994 includes useful information on factor use (capital and labor by origin), use of non-factor inputs, output levels, and revenue sources. Data from this survey are not yet available (or not directly accessible); they are currently being processed.

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Table 2.1.1. Model disaggregation of activities, factors, other inputs, and institutions

Set	Elements
Activities	*Irrigated* agriculture* (17) Hard Wheat, Soft Wheat, Barley, Maize, Other Cereal, Legumes, Fodder, Sugarbeet, Sugarcane, Sunflower, Other Industrial Crops, Vegetables, Olives, Citrus, Other Fruit, Cow, Sheep-Goat *Rainfed* agriculture* (15) Hard Wheat, Soft Wheat, Barley, Maize, Other Cereal, Legumes, Fodder, Sugarbeet, Sunflower, Other Industrial Crops, Vegetables, Olives, Other Fruit, Cow, Sheep-Goat *Other* (9) Other Animal Production, Rural services, Forestry, Petrol, Electricity, Food processing, Sugar Processing, Fertilizers/Chemicals, Public Administration, Other Urban.
Factors of production	*Resources* (4) Water, Irrigated Land,* Rainfed Land,* Pasture Land *Labor* (2) Rural, Urban *Capital* (4) Crop machinery, Livestock (by animal type & irrigated/rainfed), Other Rural, Urban
Intermediate inputs	Commodities produced by abovementioned activities (including disaggregated treatment of animal commodities — manure, fodder products, etc.)
Institutions	*Households* (5) Irrigated farmer, Rainfed farmer, Rural worker, Other rural, Urban *Government* *Rest of the world*

*The land is divided into permanently irrigated and other, primarily rainfed, areas. In this paper, the term "irrigated land" refers to permanently irrigated land, around 1.050 mn ha, excluding around 250,000 ha of seasonally irrigated land. (Cf. Table A.11).

Table 2.3.1. Basic model assumptions

Behavioral objectives	*Producers*: Profit-maximization *Households*: Utility maximization
Technology	CES function for factors; fixed intermediate input coefficients (except for food processing inputs and selected inputs to livestock activities, for which input coefficients are flexible (determined by a CES formulation).
Market - clearing variables	*Commodities*: flexible prices equalizing supply and demand; price wedges generated by government producer & consumer subsidies, and import tariffs. Imperfect substitutability between multiple sources of any given commodity. *Resources:* Flexible rent (if full utilization); Supplied on demand with zero rent (if excess supply) *Rural Labor*: Full (peak-season) employment; Migration maintains fixed ratio share of urban wage; *Urban Labor*: Downward urban wage rigidity (if unemployment); Upwardly flexible urban wage (if full employment) *Capital*: Flexible rent and full utilization