The Water-Energy-Food Nexus

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Thematic area: Renewable Energy Resources for Irrigation

Building Forward Better Initiative
Project "Strengthening natural resources management capacities to revitalize agriculture in fragile contexts"

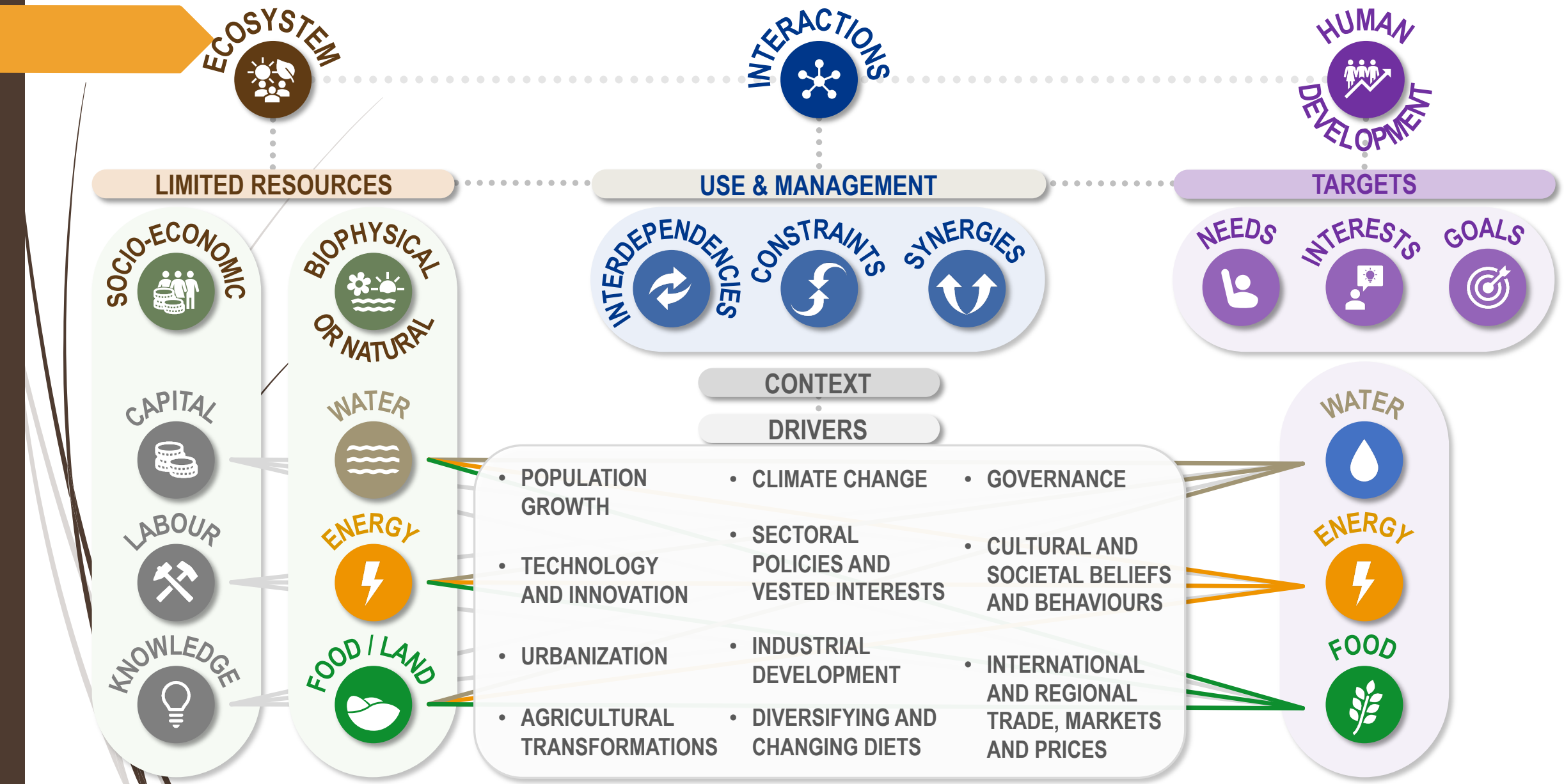
ITALIAN AGENCY FOR DEVELOPMENT COOPERATION

Introduction to the NEXUS concept

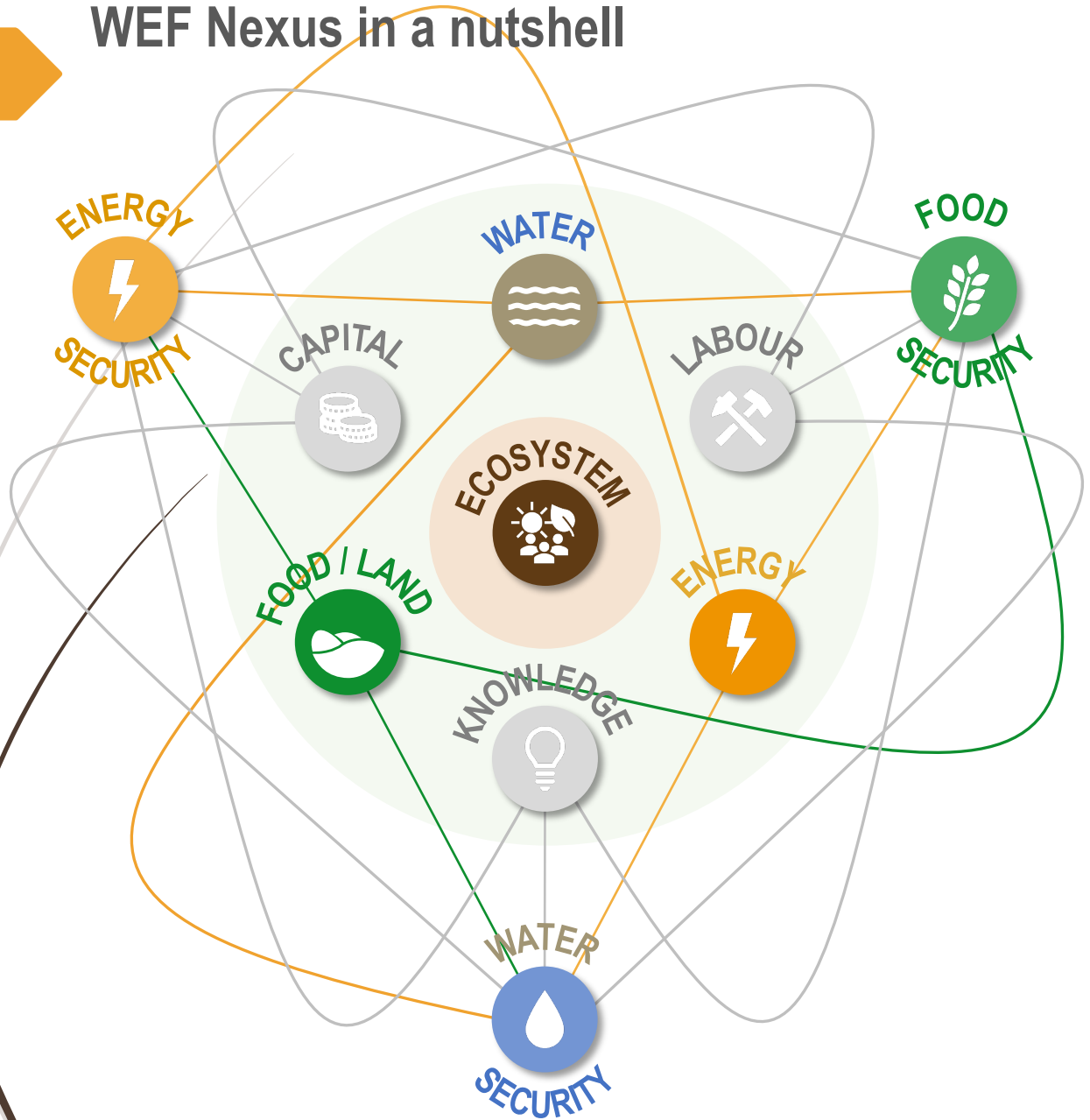
NEXUS means **CONNECTION**.

The NEXUS aims at **understanding and managing** the **complex INTERACTIONS between resources and human activities,** and work towards a more **coordinated management and use** of our **limited resources sustainably**.

The NEXUS approach is a **holistic** vision to **balance** different **goals** while maintaining the **integrity of ecosystems**.


ECOSYSTEM
INTERACTIONS
HUMAN DEVELOPMENT
LIMITED RESOURCES
USE & MANAGEMENT
TARGETS
SOCIO-ECONOMIC
BIOPHYSICAL OR NATURAL
INTERDEPENDENCIES
CONSTRAINTS
SYNERGIES
NEEDS
INTERESTS
GOALS
CAPITAL
LABOUR
KNOWLEDGE
WATER
ENERGY
FOOD / LAND
CONTEXT
DRIVERS
• POPULATION GROWTH
• TECHNOLOGY AND INNOVATION
• URBANIZATION
• AGRICULTURAL TRANSFORMATIONS
• CLIMATE CHANGE
• SECTORAL POLICIES AND VESTED INTERESTS
• INDUSTRIAL DEVELOPMENT
• DIVERSIFYING AND CHANGING DIETS
• GOVERNANCE
• CULTURAL AND SOCIETAL BELIEFS AND BEHAVIOURS
• INTERNATIONAL AND REGIONAL TRADE, MARKETS AND PRICES
WATER
ENERGY
FOOD

WEF Nexus in a nutshell



"Everything is connected."

"The way we use one resource to cover a certain need can impact others resources and jeopardize fulfilling other targets."

The importance of the WEF Nexus (I)

Water, **energy** and **food** are **essential** for human well-being and sustainable development.

Demand for **freshwater**, **energy** and **food** will **increase significantly** over the next decades under the pressure of: population growth and mobility, cultural changes, economic development or climate change.

Consequently, **interconnections** between WEF Nexus sectors **will exacerbate** in the future, with **increasing competition for resources** between sectors.

Globally, **60% more food** will be required in 2050, total **water withdrawals for irrigation** will increase by **10%** in 2050, and **energy** consumption will grow by **50%** in 2035.

Traditionally, **water**, **energy** and **food**–related challenges have been addressed **individually**, leading to **unpredictable impacts** across sectors and scales for livelihoods and the environment.

Decision-making processes require a **cross-sectoral coordination**, hence considering the dynamic nature of complex systems.

The importance of the WEF Nexus (I)

The **holistic** WEF Nexus approach contributes to **anticipating potential trade-offs and synergies,** setting an opportunity for **stakeholders** to design, appraise and prioritise **integrated response options** that are viable across different sectors.

A WEF Nexus perspective is needed to **improve water**, **energy**, **and food security integrating the management of the limited resources** while transitioning to a more sustainable economy.

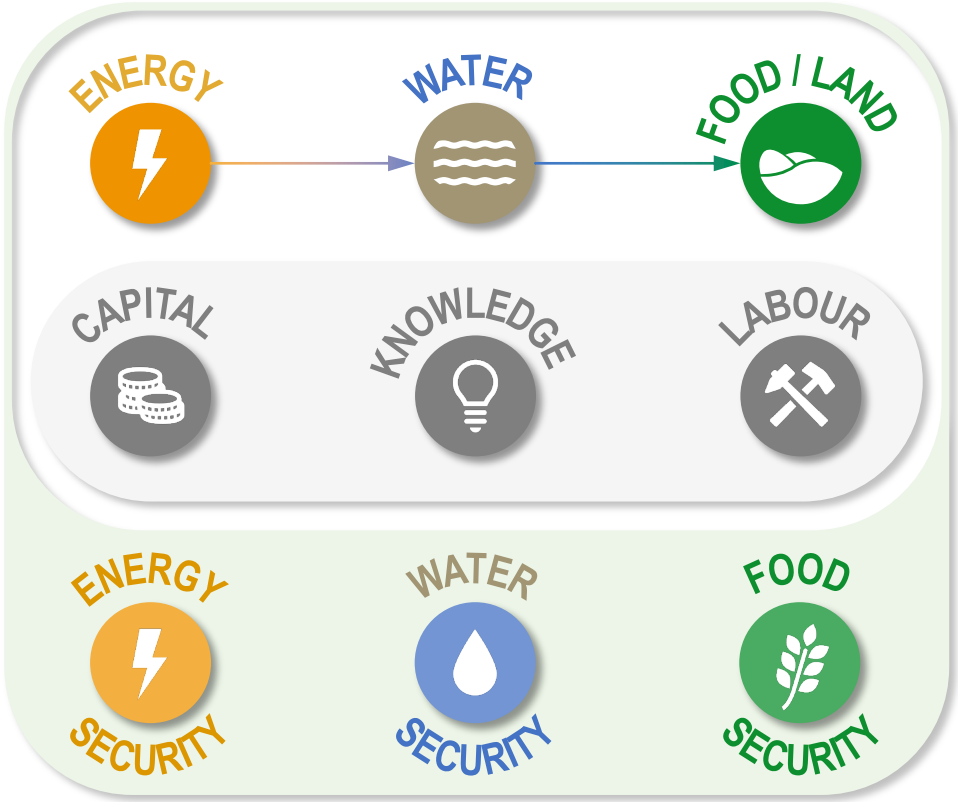
The WEF Nexus approach directly addresses three Sustainable Development Goals (SDGs):

... but indirectly impacts all 17 SDGs

Solar-Powered Irrigation Systems (SPIS) from a WEF NEXUS approach

Solar (Water) Pumping for Irrigation

Solar Energy is used to Pump Water, which is used for Irrigation



Potential BENEFITS of SPIS for FARMERS from a WEF NEXUS approach

When **properly** deployed:

ENERGY SUPPLY Decentralized, reliable, predictable and **environmentally** sustainable.

ENERGY SECURITY Less dependence on energy resources availability or prices volatility (diesel, electricity).

WATER SECURITY Improved and safe access to water. Buffer for droughts/dry seasons effects

CLIMATE MITIGATION No greenhouse gas emissions from SPIS use.

CLIMATE RESILIENCE Adaptation by mobilizing water when rainfall patterns are erratic.

FOOD SECURITY Stabilization, increase and diversification of food production.

FOOD PRODUCTIVITY Improved livelihoods: increased productivity (additional cropping season, higher value crops)

LOW O&M COSTS Low operation and maintenance costs. No need to reinvest earnings in fuel.

DECREASING PRICES Drop of solar panels costs make SPIS economically viable and competitive

COST EFFICIENCY Reduced costs in the long run.

SCALABLE Modular solutions

Potential BENEFITS of SPIS for GOVERNMENTS from a WEF NEXUS approach

When **properly** deployed:

ACESS TO ENERGY Contribution to rural electrification.

RENEWABLE TARGETS Progress in renewable energy targets.

ENERGY INDEPENDENCE Reduced dependence on energy imports.

RURAL DEVELOPMENT Stabilization, increase and diversification of food production.

GREEN GROWTH Reduced carbon footprint of irrigation. Promotion of green growth.

FOOD PRODUCTION Increase of agricultural production and diversification

ADAPTATION TO CHANGES Preparation for increasing demands and dietary changes.

JOB CREATION Job creation potential in the renewable energy sector (suppliers, services)

FUEL SUBSIDIES Possibility to reduce energy subsidies for fossil fuels

Potential "additional" BENEFITS of SPIS from a WEF NEXUS approach

EXTRA SERVICES PV surplus can supply energy for other uses (e.g. milling, processing)

EFFICIENCY INCREASE In case PV is installed in floating structures on water bodies.

WATER QUALITY Through integrated **filtration** and less pollution (inadequate fuel handling, i.e. diesel pumps)

GENTLER ABSTRACTION Lower hourly yields over more hours; less risk of borehole collapse.

TIME SAVING In watering-related tasks, to be used in other income-generating activities.

GENDER EQUITY Women and children, generally in charge of watering, can have time for new activities.

"UPGRADED LOST SPACE" **High-value crops** under PV, or as **shading for animals**.

HIGH-EFFICIENCY IRRIGATION Easy to integrate pressurized systems such as **drip irrigation**.

ROTATING IRRIGATION SCHEDULE To increase productivity while allowing to keep low SPIS size.

NEW BUSINESS MODELS Associated to SPIS: Cooperatives, pay-as-you-go or "one-stop shop"

INCOME DIVERSIFICATION Surplus food production can be sold and provide an extra income

Potential LIMITATIONS and RISKS of SPIS from a WEF NEXUS approach (I)

OVERUSE & OVERABSTRACTION Leading to decrease of water tables, depletion and degradation of aquifers (lower water security).

INSTITUTIONAL FRAMEWORK Lack of groundwater management institutions.

OVERESTIMATED RESOURCES Due to lack of data or finance to correctly measure

DIFFICULT TO CONTROL OFF-GRID SPIS Decentralized systems are difficult to regulate. Risk of ilegal pumping.

INADEQUATE IRRIGATION "Free, unlimited water" thinking. Lack of knowledge on irrigation calendars or water requirements

ENERGY-USE INCREASE In case of adoption of pressurized irrigation systems in rain-fed crops or decreasing water tables.

LACK OF AWARENESS Low adoption rates due to unfamiliarity with technology (users, institutions, banks)

INSUFFICIENT KNOWLEDGE ON SPIS Lack of skilled personnel to correctly design, operate or mantain fit-for-purpose SPIS.

NO QUALITY STANDARDS Lack of codes to guarantee quality.

LACK OF TRUST Between farmers, utilities and government to innovate

Potential LIMITATIONS and RISKS of SPIS from a WEF NEXUS approach (II)

HIGH INITIAL COSTS Still relatively high investment not affordable, or that implies a risk that cannot be tolerated.

FINANCIAL ACCESS Lack of financial instruments or possibility to access financial support

TAX ON IMPORTS Increase of already relatively high equipment costs may distort prices.

HARMFUL WASTE From mining and production of toxins and rare minerals in PV modules.

CLIMATE CHANGE Potential risk of more frequent droughts, reducing water resources

LACK OF SERVICES No on-site distribution channels (private suppliers or markets) to provide spare parts stock. No maintenance services.

SOCIAL JUSTICE No posible adoption in case of not being tenant farmers.

THEFT RISK And hence often not covered by insurance, as a prerequisite for loan finance. Resale risk.

Some POLICY INSTRUMENTS for SPIS promotion

SUBSIDIES & LOANS

Direct and indirect for capital investment (Capital subsidy, low-interest loans).
No consideration of: water availability, inefficiencies and potential long-term effects [Morocco, India].
Market distortions (technology provision below cost), causing losses or even bankruptcy.
Cost recovery prevention for utilities/distribution companies. No investment in new infrastructure.
Usually restricted to land owners [Rajasthan, Punjab]

TAX EXEMPTIONS & REDUCED TRADE BARRIERS

For foreign suppliers of PV modules, pumps or wirings.

NEW BUSINES MODELS

Pay-as-you-go; Contractor model; One-stop shop

WATER ACCOUNTING

Water meters, remote monitoring.
Risk of tampering, vandalism or corrupt local agents [Jordan, Syria]

FEED-IN TARIFFS

Price incentives for electricity sold to the grid [Jordan, "solar farming"].
Not applicable to off-grid SPIS.

RESTRICTED POWER

Limited power supply for irrigation.
Not applicable to off-grid SPIS.

PARTICIPATORY MANAGEMENT

CAPACITY BUILDING FOR FARMERS

Conclusions and recommendations

NEXUS (comprehensive) planning is essential for a proper deployment of SPIS

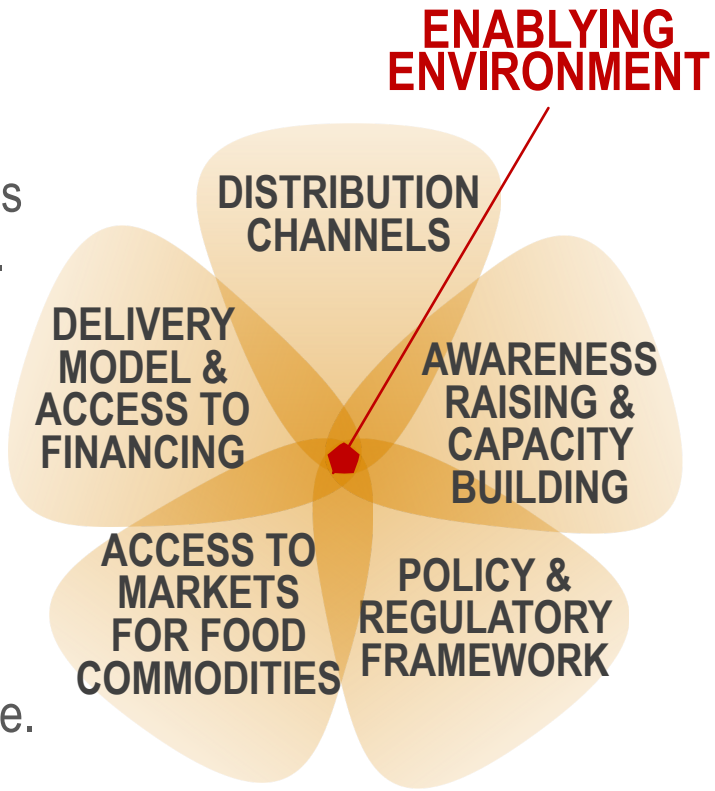
SPIS can provide numerous direct and indirect **benefits**, but **risks and limitations** need to be considered carefully.

A **preliminary integrated assessment** of resources **demand** and **availability** is vital as part of the **holistic planning** process for well-defined geographic areas.

Monitoring strategies (e.g. remote monitoring) can be key to avoid **overabstraction**, as well as awareness on water efficiency.

Creating an **enablying environment** is crucial.

Policies need to be **fit-for-purpose**, inclusive and defined from a NEXUS approach, whose **impacts** need to be evaluated. **Pilot testing** may be advisable.



Thank you!

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