Supporting Water-Food-Land Nexus policy coherence through integrated agrifood advisory and extension system in Egypt

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Abstract. Building policy coherence is significant in governing natural resources, especially in a changing climate and growing population. Designing and implementing coherent climate-adaptive water productivity policies through holistic and integrated knowledge could manage the growing demand for food and water, and sustain small-scale farmers' livelihoods and economies, which is the aim of this research. This study focuses on the analysis of power dynamics and the social network that evolves around the control of information and technical assistance that shape policy narratives. Results showed that donors and financial institutions are the primary powers to control and organize knowledge and technical assistance linked to soil-water conservation especially when it's combined with mobilizing relevant funds. Many smallholder farmers still adopt traditional patterns of cultivation due to the siloed knowledge gaps in the extension services of governmental entities, the unreachability of extension services, the lack of trust in their guidance, and the absence of innovations' scalability. Building integrated extension services between ministries, by providing equal and suitable financial packages. This would be feasible by managing the coordination with financial institutions, monetary and non-monetary incentives, and building on existing farmers' collective organizations and farmers' pioneers to enable a sociological transition to water productivity.

1 Introduction

With a population of over 100 million citizens, Egypt's demand for water and food production (plants, animals, and fisheries) is expanding in a water, land, food, and climate-stressed country. According to the Ministry of Water Resources and Irrigation (MWRI), Egypt's per capita share of renewable internal freshwater dropped to almost half the minimum amount required for water security, 585 compared to 1,000 required cubic meters annually [1].

Researchers have revealed that agriculture practices (including fisheries) consumed 80 to 85% of water resources; the amount of irrigation water used increased annually, especially for summer crops; and poor irrigation management degraded land, which in certain areas diminished its ability to sustain the production of food [2][3]. Additionally, according to a key informant interview, many aquaculture farmers use untreated drainage water, which limits their fish production and accessibility to better markets, impacting their income and livelihoods. Furthermore, severe land fragmentation reduces yield productivity and demotivates farmers from cultivating their lands [4]. The excessive use of fertilizers or pesticides deteriorates the long-term soil characteristics, increases its salinity, and affects food quality [5][6]. Besides, high temperature accentuates annually the Mediterranean Sea Level Rise (SLR) affecting primarily the Northern Delta region. The SLR subsequently increases salinity in the Delta groundwater and the soil, reducing agricultural yields [7][2]. These major trade-offs between food, land, and water (FLW) systems under harsh climate conditions and high population intensify existing water scarcity and limited arable lands, and therefore, attenuate the agrifood systems to operate at full capacity and jeopardize the livelihoods of farmers and their well-being.

This is evident when the share of Agriculture in the Growth of Domestic Product fell from 11.4 in 2021 to 10.9 in 2022 [8]. According to Figure 1, the growth rate has decreased from 26% in 2016 to 19% in 2022 of total employment [9], despite an increase in the number of male farmers, which indicates that a high population doesn't translate into more engagement and employment in agriculture. Figure 1 also shows that more women have exited the agrifood industry over the years. It's expected that better integration between water, land, and food in an arid climate context would serve economic performance and productivity.

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Therefore, to create more productive, resilient, and responsive water, food, and land systems in Egypt, there is a need to optimize climate-adaptive water productivity mechanisms. However, a key challenge lies in the fragmented and uncoordinated policy and governmental actions, creating synergies and minimizing trade-offs to sustain the use and management of water and land resources [10]. To create a road map, there is a need for a comprehensive policy coherence that acts on improving water productivity that combines water, land, and food systems, in addition to climate change and socio-economic vulnerabilities.

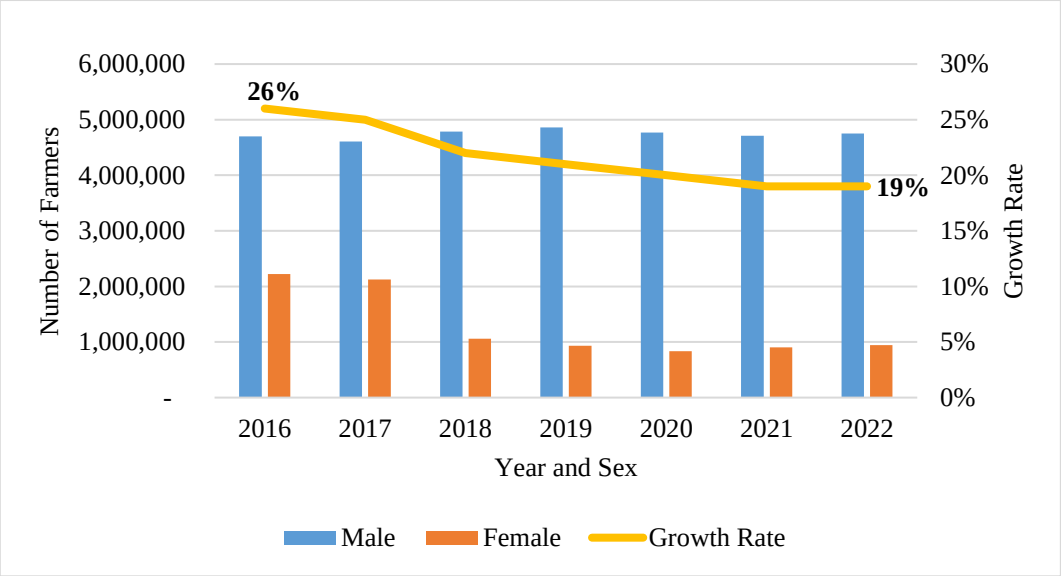

Figure 1: Percentage of Employment in Agriculture (Growth Rate and Labour Force scale) – Source: Authors' Analysis adapted from ILO and World Bank data

2 Method

The National Policies and Strategies for Agrifood System Transformation (NPS) is a CGIAR initiative that is active in eight countries, including Egypt. The purpose of the initiative is to analyze the coherence of water productivity policies, which falls under Sustainable Development Goal 17.14., which calls on countries to establish participatory, coordinated, and integrated governance and policy actions after decades of sectoral policies that created shortsighted solutions and less effective impact [11]. It aims to examine the current sector-based institutional and governance arrangements fueling the mismanagement of natural resources of water, land, and food. By understanding the institutional and governance setting in place, the authors uncover the existing distribution of power in this sector, the actors involved, their roles and positions, their different interactions, who makes decisions, who can influence decisions, and who are affected by decisions, and examines their source of funding [12][13].

'Power' is described as the ability to influence, persuade, or coerce others [14]. Many factors affect a stakeholder's relative power from which, in this paper, the control of information and skills. This study examines power analysis and social networks of mobilizing and exchanging knowledge and expertise on climate-adaptive water productivity. Therefore, by examining the interest groups associated with crafting and implementing decisions on water productivity for better climate resilience in Egypt, the authors will be better positioned to explain how policy narratives are shaped, and how will they likely evolve. Stakeholders and interest groups that control information and expertise range from donors and financial institutions to research centers, extension services under the Ministry of Agriculture and Land Reclamation (MALR), advisory services under the Ministry of Water Resources and Irrigation (MWRI), training centers under the Lakes and Fisheries Resources Protection and Development Agency (LFRPDA) and civil society organizations (Figure 2).

This paper aims to respond to the question of ***the extent of coherence in the FLW policymaking process related to holistic and integrated knowledge of climate-adaptive water productivity in Egypt.***

This research was developed through an in-depth multidisciplinary literature review and qualitative methods through key informant interviews with various stakeholders, ministries, non-profit organizations, large landholders, researchers, SMEs, and community-based organizations.

Figure 2: Power analysis and social network of Knowledge and Expertise related to Climate-adaptive water productivity – Source: Authors' Analysis

3 Findings

3.1 Political Economy of the agriculture sector in Egypt

Part of the analysis of the power and institutional arrangements of the agrifood system is attributed to the influence of different political ideologies that give rise to the emergence of various interest groups that contribute to shaping the national and local water and agriculture management policies.

In the fifties, the executive organs of the state had higher weight and power over politics, the economy, and society. Socialism was the essence of the government mandates, from which its agricultural policies, and therefore, it supported Egyptian farmers through the redistribution of agricultural lands, the provision of subsidized seeds, fertilizers, and pesticides, and upholding rigid relationships through extension services after the implementation of the state-mandated agricultural cycle [4][6]. In the seventieth, however, the government had shifted agriculture policies under the influence of economic reforms and structural adjustment programs as part of a more liberal stance. These market policies had aggravated the precarity of smallholders over the years, who found themselves vulnerable, facing private sector monopolization, clientelism, oligarchic elites, and crony capitalists [15].

In brief, the political economy in Egypt reflects a continuation of these neoliberal policies in the agriculture sector. The Global Food Security Index (GFSI) shows a static score of access to extension services, which continues

to be 50, compared to an average of 79.2. Similarly, the public investment in agriculture research score has dropped from 11.1 in 2016 to 8.1 in 2022 [16]. Several key informant interviews highlighted the shrinking role of the Ministry of Agriculture and Land Reclamation (MALR) in managing natural resources and the growing influence of the private sector [14][6]. Although the ministry still played a role in extension services, it gradually diminished. Hence, many smallholders still rely on traditional patterns of production and marketing, and the absence of forms of female farmers' empowerment as Figure 1 shows the number of Female Farmers falling from an average of two million in 2016 to less than one million (945,313) in 2022 [18]. Without good knowledge and guidance from the extension services on the management of agricultural inputs and outputs, the vulnerability of smallholder farmers would persist, creating a flux of farmers who exit the sector or will not be willing to enter it. The Food and Agriculture Organization of the United Nations (FAO) defines small-scale holders through multidimensional approaches, first, by the small scale of their lands, not exceeding 3 feddan (1 Feddan = 0.42 Hectare (ha))), and second, by their economic status related to generating enough income from working their water, land, and food [4].

3.2 Power Dynamics on the Control and Mobilization of Knowledge and Information

3.2.1 Dominant Role of Financial Institutions and Donors

One of the power pillars examined is the ability to mobilize knowledge skills and expertise, and where many key informant interviewees have highlighted the significant weight power of knowledge in bridging the gap towards more policy coherence between food, land, and water towards climate resilience. While some respondents argued that regulations and legislative authority are the essential types of power that drive decisions and practices ahead. Others argued that farmer's collective organizations wield power because of their large numbers and the social and familial ties they form at the community level, and therefore, they should gain new knowledge about new approaches and technologies to soil-water conservation, especially in saline lands like in the Delta region, as well as gain marketing and price negotiation skills to boost their economic status and income. Therefore, the ability to improve climate-adaptive water productivity depends on the structure of extension services, farm field schools, and collective organization of farmers such as Water Users' Associations (WUAs).

The power and social network of information and technical interactions, in the water productivity policy arenas, reveal that donors and international non-profit organizations are the dominant institutions, especially when interlinked with mobilizing economic capital. Figure 3 depicts the centrality of the Food and Agriculture Organization (FAO) in the network, followed by the Netherlands, which is a key player in providing technical, educational support, and networking platforms to Small and Medium Enterprises (SMEs), farmers, and WUA, but also ministries and research centers through bilateral agreements with Dutch universities and companies. Dutch companies like IrriWatch and Delphy B.V. offer agricultural training and services transforming water and agricultural lands in Egypt. After receiving a scholarship from the Netherlands, an interviewee learned about the negative impact of commercial farming on soil erosion, and she began to assess market demand, swapped to smart agriculture, and started to install drip irrigation.

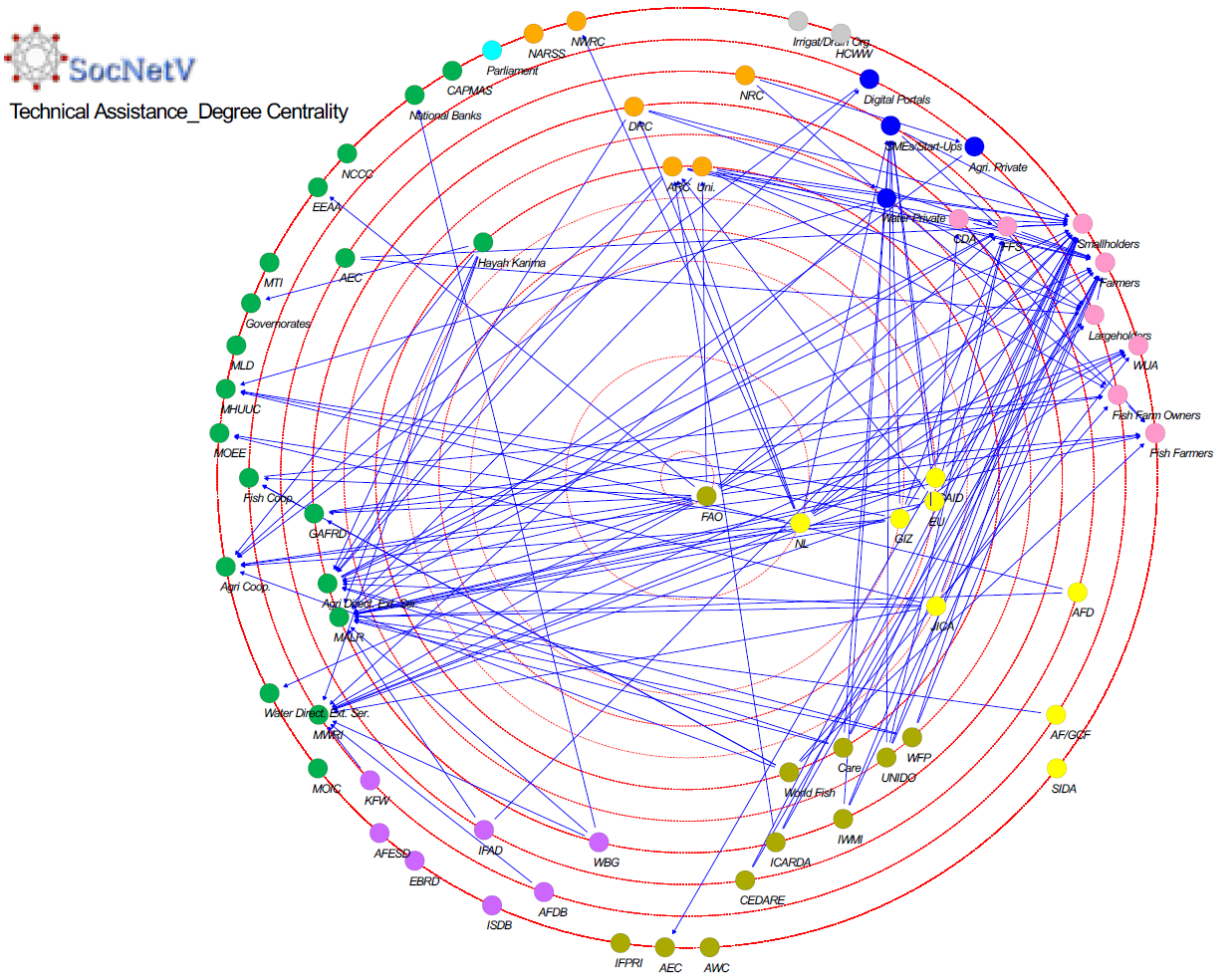

Figure 3: Technical Assistance Social Network of Climate Adaptive Water Productivity – Source: Authors' Analysis

3.2.2 Governmental Extension Services Gaps:

The mobilization of knowledge and expertise is siloed between MALR, MWRI, and LFRPDA advisory systems. There is no platform to link different knowledge management from the various institutions, many research centers exist with many solutions, but the application is individual-based and part of a commercial framework according to interviewees. There is no integrated knowledge between all institutions. Therefore, policy coherence could play a role in integrating governmental extension services to produce concise and timely efficient information to farmers that mitigates trade-offs and increases integrated planning of water saving, ecological farming of the land, and maximizing their production.

It's worth noting the absence of MALR, MWRI, and LFRPDA's extension services from the center of the technical assistance network of interactions where one farm owner reported the unreachability of their services. The extension services staff are traditional, they don't acquire new knowledge about innovations and solutions; they just follow the brochure of the ministry for each crop. Consequently, farmers still use traditional irrigated water systems, low-quality water, intensive use of inputs, and inefficient systems of technology transfer. In addition, farmers still lack access to diversified forms of credit and lack poor negotiation skills that could better position them in the market and supply chain series.

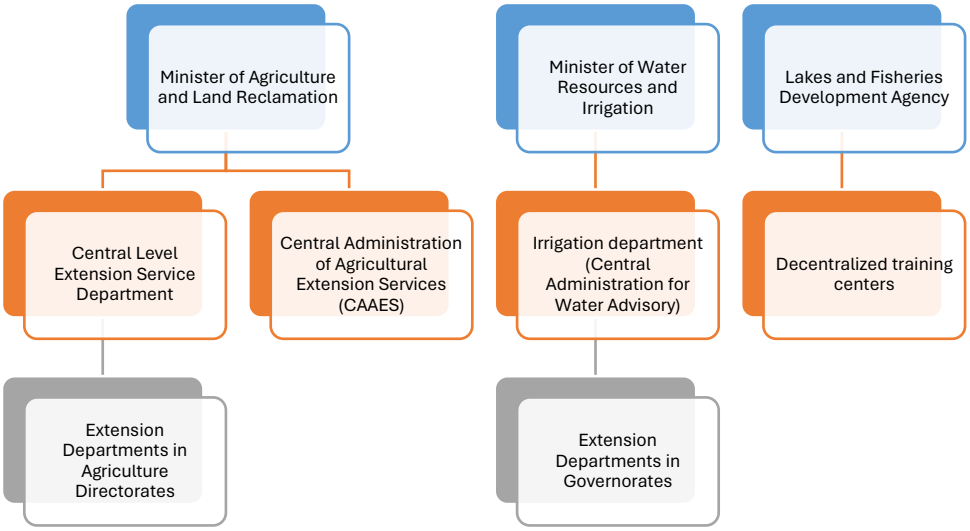

Figure 4: Department of Extension services under the three main institutions – Source: Authors' Analysis

Moreover, the key informant interviewees mentioned that the state has halted hiring public officials in its apparatus as part of a strategy to reduce public sector personnel. This has affected the employment of agricultural and water advisors across the governorates, and thus in some areas, guides have retired, and no one was hired to replace them.

Furthermore, some respondents highlighted the absence of an enabling environment for the extension services team through the absence of suitable financial packages and the lack of specialized and complex capacity building on climate-adaptive water productivity, as well as access to better markets and improved farmers' income.

Many pilot tests are conducted at farm field schools for each governorate but without the scalability of innovations. Scientific research has many phases, it starts with the need to prove the innovation on the field level, and then scale it. To ensure farmer's trust in the process, innovations need to be tested on a large scale and under different circumstances. Moreover, water needs to be an intrinsic aspect of farmers' training linking its effective management with increased productivity and income.

Extension messages and communication channels should also be developed and diversified. Some digital platforms offer contractual farming services linking farmers with suppliers. However, they are easily accessible for large-holder farmers but difficult with smallholders and renters' farmers when illiteracy rates are high in rural areas and where they don't acquire smartphones (personal communication, 2023). Similarly, the Asmaknet application, aimed to increase the marketing strategy of aquaculture in Egypt, however, it wasn't sustainable (personal communication, 2023).

4 Recommendations

The first recommendation is to support an integrated governance between the extension services of the three relevant government entities on the central and governorate levels, that would enable information, skills, expertise, and technological flow for the benefit of water, land, and food systems management. The integrated extension services team should be offered an equal and suitable financial package with relevant complex training. This team could then provide condensed training and knowledge to small businesses and civil society organizations working while collaborating and better managing financial resources from donors and financial institutions.

The main purpose of these integrated extension services would be the scalability of Agricultural Innovations. CGIAR has established an Innovation Packages and Scaling Readiness (IPSR); it's a quantitative tool that measures the readiness and use scale of the agrifood system innovation.

Generally, innovations are risky and uncertain, farmers should be offered incentives through direct financial means or non-financial assistance through farm field schools and provision of agricultural inputs that would sustain

their income during the application of innovations. Financial means could be offered as part of the collaboration with different financial institutions. Discussion also arises about the significance of accompanying the agroecological transformation with the sociological and anthropological transformation, as many farmers fear the judgment of others or failure to try something new. This is how an integrated system of extension services with other partners and stakeholders in the network should diversify their services according to the needs of farmers. In addition, SMEs and Community Development Associations can boost the sociological and economic water productivity of farmers by linking farmers with these digital tools and supporting their marketing and export strategies.

The last recommendation of an integrated system is to build on existing farmers' collective groups from which the water users associations. The extension services should build on the existing pilot experiences of selecting pioneer farmers to volunteer and adopt an experiment on their lands and transform it into a farm field school. Farmers gather once each week and ask the pioneers questions about their productivity, pests, diseases, and prices of their

5 Conclusion

With a growing population, the demand for food and water is increasing. However, many trade-offs between water, land, and food system arenas in a climate change context hamper any progress and significant impact. Therefore, a comprehensive policy coherence on climate-adaptive water productivity is needed. This study examines the power dynamics and the social networks that shape climate-adaptive water productivity policy narratives related to the provision of technical (knowledge and skills) assistance and sharing expertise with other stakeholders. The study unfolds two significant results, the first one is the dominance of donors and financial institutions on the network of technical assistance, and the second is the absence of governmental extension services and the gaps that lie in policy making and implementation. The study recommends building policy coherence through an integrated extension system between the Ministry of Agriculture and Land Reclamation, the Ministry of Water Resources and Irrigation, and the Lakes and Fisheries Resources Protection and Development Agency. This integrated system should support holistic knowledge sharing and scaling research innovations with farmers to better support climate-adaptive water productivity. It should be accompanied by a sociological and anthropological transition to the agricultural communities. Finally, extension services should be built on existing organizational and community structures of farmers and pioneers.

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