RESEARCH REPORT

124

# Institutions, Impact Synergies and Food Security:

## A Methodology with Results from the Kala Oya Basin, Sri Lanka

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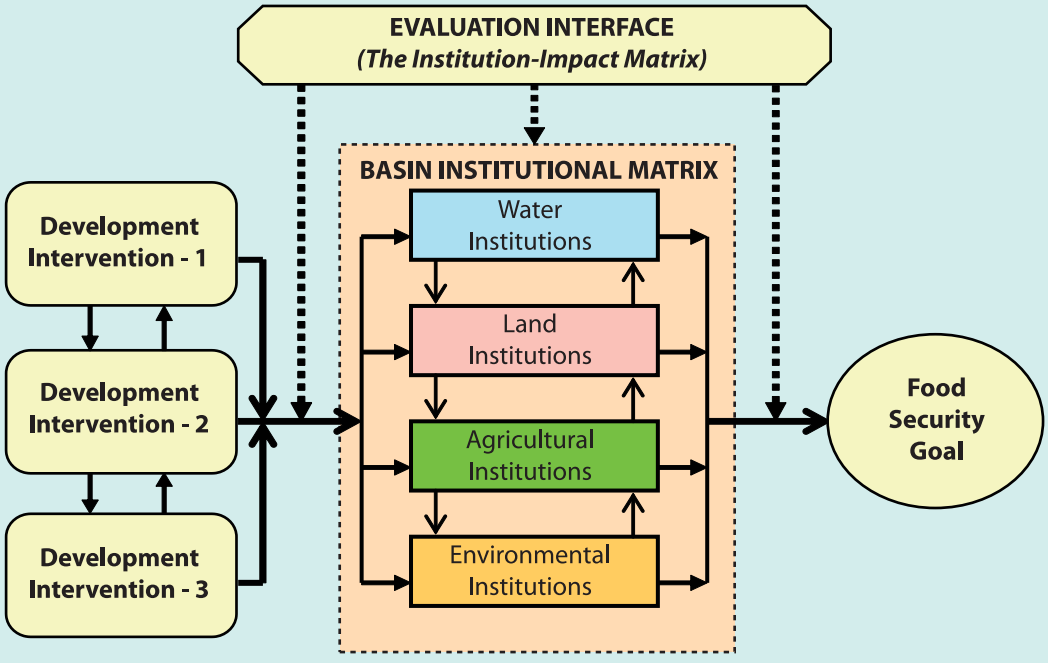


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*Research Report 124*

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*Front cover graphic:* Conceptualizing Institution-Impact Interaction

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# Contents

## Summary

With increasing investments on development programs, there are obvious concerns on their actual impacts. But, two key factors that influence the extent and sustainability of these impacts, though well known, continue to lack proper treatment both in the economic literature and in development policy. They are the roles that institutions play in impact generation and transmission and the impact synergies that a development intervention derives from the past, ongoing, and planned interventions. Exclusion of these factors is a serious problem, particularly in achieving *meta*-development goals such as food security, where the realization of the final goal is linked with the progress of several intermediate but related goals of a hierarchy of programs spanning even across sectors.

This paper develops and applies a methodology that explicitly captures the effects of institutions and development synergies within a unified framework and quantitative context. The framework is developed (a) by taking three development interventions (crop diversification, system rehabilitation, and bulk water supply), (b) by tracing their impact pathways and interaction points, (c) by locating relevant institutions in these points and pathways, and (d) by linking them all with the final goal of food security. This framework is, then, translated into a system of 21 sequentially linked equations using a set of development, institutional, and impact variables. The methodology is illustrated by taking the Kala Oya Basin in Sri Lanka as the empirical context and using perception-based qualitative information from 67 experts as the data source.

The estimation of the model provides considerable insights on the nature of both the roles that different institutions play at various points of the impact pathways as well as the synergies that a given development intervention derives from others. The sensitivity analysis performed with the reduced form equation suggests that, in terms of the marginal effects on food security, market institution has the highest effect, followed by others such as price regulation and trade policy. Unlike these institutions with a positive effect, there are others with a negative contribution such as land tenure and rural development policy. Although the results are based on the learned judgment of the experts, they still have qualitative significance and policy relevance as an indication of prevailing consensus on institutional roles and development impacts.

The paper adds significantly to existing understanding on institutional analysis, development planning, evaluation methodologies, and, even, empirical procedures. From the perspective of practical policy, this paper has two main contributions. First, it demonstrates why and how it is important to account for the institutional impacts and development synergies possible from the past, ongoing, and future interventions when planning for and implementing a new development program in any given region. Second, it also provides a diagnostic tool for locating the weak spots and slack links in various impact pathways as well as for identifying the institutions and impact chains that are to be strengthened to improve the impact flows of development programs.

# *Institutions, Impact Synergies and Food Security: A Methodology with Results from the Kala Oya Basin, Sri Lanka*

*Rathinasamy Maria Saleth, Ariel Dinar, Susanne Neubert, Bandi Kamaiah, Seenithamby Manoharan, Sarath Abayawardana, Ranjith Ariyaratne and Shyamalie de Silva*

## Introduction

Governments and development agencies constantly plan, implement, and evaluate various development interventions, i.e., projects, programs, and policies. These interventions vary in scale and coverage, ranging from those specific to a group, region, resource, or sector, to those universal and global in scope. Considering the flow and magnitude of investments involved, there is an understandable concern over the actual impacts that these interventions generate. Despite this concern, two key aspects with a central role in determining the magnitude and sustainability of development impacts continue to lack recognition and treatment both in the economic literature and in development policy. These are: (a) the role institutions play in impact generation and transmission, and (b) the synergies inherent among past, ongoing, and planned interventions. The insufficient treatment of institutional roles and the failure to account for development synergies could create fundamental errors in development planning and impact assessment. This problem is particularly serious in the context of *meta*-development goals such as the Millennium Development Goals (MDGs),[1] where the realization of the final goal is linked with the realization of several intermediate but related goals of a hierarchy of development interventions, all of which require an effective institutional framework for their implementation and monitoring.

Since the MDGs are now treated as an internationally accepted framework for development planning and progress monitoring (UN 2006) the issue of capturing the facilitative roles of institutions and impact synergies assume policy relevance and practical importance. Unfortunately, this issue is neither a part of the framework nor a part of the tools that the MDG administration (UNDP 2006) has developed to support the design, evaluation, and monitoring of the MDG-oriented development interventions. This gap also persists in the small but growing literature that aims at assessing the progress on MDGs (e.g., World Bank and IFPRI n.d.; Sahn and Stifel 2002; Haines and Cassels 2004). Since these studies only extrapolate the future progress based on *ex-post* performance up to a given year, they fail to incorporate the *ex-ante* dimension of what would happen when institutional performance is enhanced and development synergies from completed, ongoing, and planned interventions are reckoned.[2] This paper aims to fill

[1]The MDGs are the outcome of the United Nations Millennium Declaration, which was adopted by all 189 Member States of the United Nations on September 8, 2000. There are eight MDGs along with their 18 specific targets (see Annex A) that set time bound and measurable goals and targets for countries and regions for combating poverty, hunger, disease, illiteracy, gender discrimination, and environmental degradation and improving global governance by the year 2015. These goals and targets are accepted both by the governments and UN agencies as well as development and donor organizations as a framework for monitoring and evaluating development progress.

[2]For example, Haines and Cassels (2004) have first estimated a trend line with *ex-post* data for 2 years and, then, used this to extrapolate the future trend until the target date of 2015. The distance between these two trend lines is taken as the gap between

this gap by developing a methodology that can directly capture both the institutional impacts as well as the development synergies within a unified framework and quantitative context. The methodology is demonstrated by taking food security related to Goal 1 of the MDGs as an example, Kala Oya Basin in Sri Lanka as the empirical setting, and stakeholder-based *ex-ante* qualitative information as the database.

From here onwards, the paper is structured as follows. The section, *Impact Synergies and Institutional Roles: An Ex-Ante Assessment,* discusses the welfare impacts of development intervention and shows the policy value of its *ex-ante* evaluation. The section, *The Analytical Framework,* sets the conceptual foundation and analytical framework of the proposed methodology and describes the institution-impact matrix. The section, *The Empirical Context: The Kala Oya Basin, Sri Lanka,* describes the empirical context and data generation. The section, *Empirical Specification of the Model,* applies the institution-impact matrix to the development and institutional context of the study region. The section, *Data and Results,* presents and analyzes the results of the econometric models of institution-impact interaction and illustrates the role of institutional impacts and development synergies. The final section, *Conclusions and Implications,* concludes with the analytical and empirical insights of the paper, the limitations of the present attempt, and the scope for its future extension and refinement.

## Impact Synergies and Institutional Roles: An *Ex-Ante* Assessment

When selecting policies, policymakers usually make an ex-ante assessment of their effects both on total welfare and also on its distribution across groups.[3] But, the *ex-ante* issue of how this welfare and its distribution would change significantly if the roles of relevant institutions and synergies of related policies are ignored in such assessments. The policy value of such *ex-ante* consideration can be graphically demonstrated using Figure 1, which is an adaptation of a framework suggested by Just et al. (2004).

Figure 1 depicts a simple economy with two individuals (or groups), i.e., I (rich) and J (poor), who, with a given bundle of resources, can produce/consume two goods, i.e., food (F) and recreation (R). Given the current technologies and institutions, the production possibility frontier for the economy is OP. Assume that the economy is in a status quo at $(i,j)^{o}$ with corresponding welfare levels for the two-person society. From the allocation space within the Edgeworth Box (as defined by the area 0O×0P), we can establish that J's welfare is: JF(0)+JR(0) and I's welfare is: [P-JF(0)]+[O-JR(0)]. Now, suppose that the government wants to take the economy towards the frontier OP and improve, thereby, both the total welfare and its distribution. For this, it considers two polices, which could *a priori* achieve such economic and social objectives, i.e., a 'dashed' (dashed line) policy intervention (D) and a 'solid' (solid line) policy intervention (S). As can be seen from Figure 1, the 'dashed' policy intervention moves the economy from $(i,j)^{o}$ to $(i,j)^{D}$ and the 'solid' policy intervention moves the economy to$(i,j)^{S}$. Both policy interventions are Pareto optimal in the sense that they satisfy the condition of utility maximization for both individuals/groups. But, the 'dashed' policy is less efficient as it falls short of the production possibilities frontier (OP) and ends with an inner frontier, O'P'<OP. However, from a

[3]The distributional impacts are particularly important in policies, such as the MDGs, which, by their nature, target the special and disadvantaged population groups.

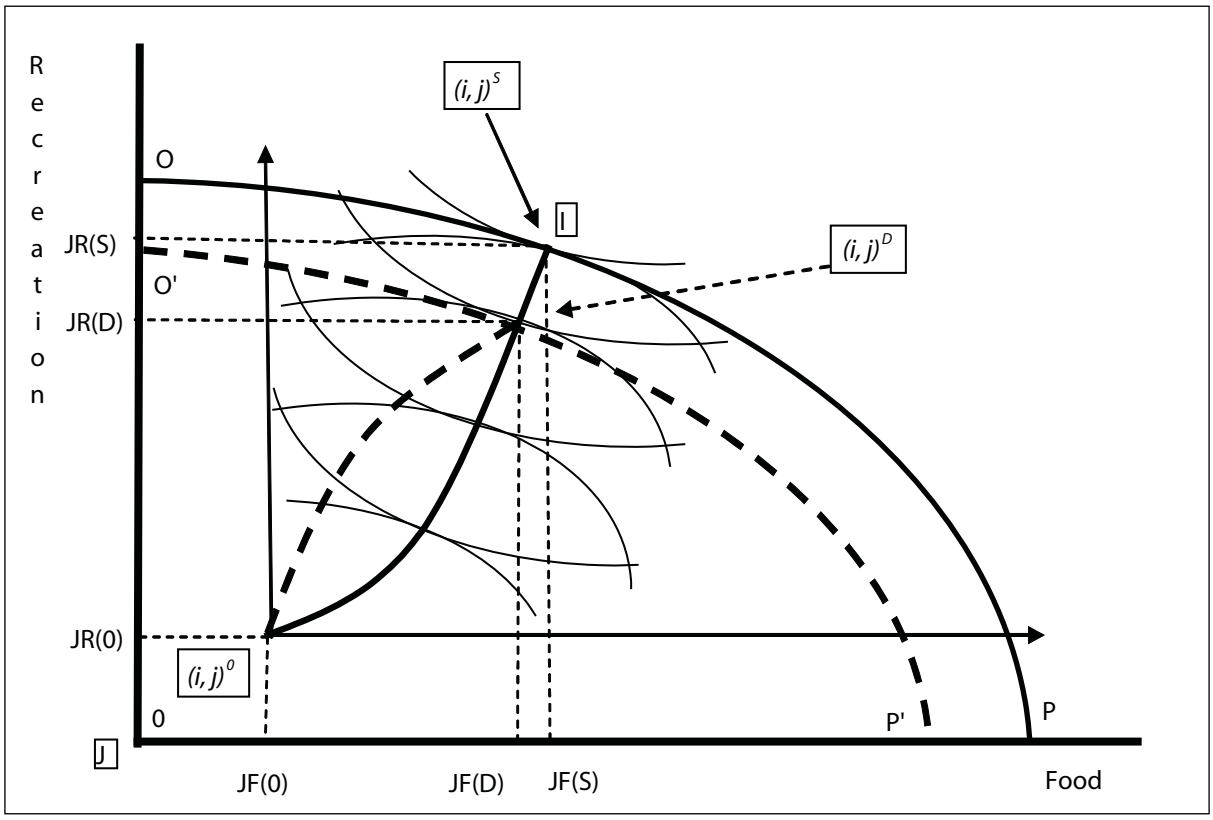



FIGURE 1. Evaluation of alternative policy paths and societal welfare.

political economy perspective, the 'dashed' policy becomes the second best option and it can very well be the final policy choice of the government.[4]

In the discussion so far, the focus is on the welfare and distribution implications of two alternative policies. In this case, an *ex-ante* assessment of the development path and its economic implications is usually conducted with actual and expected information before the policy choice is made. But, such assessments do not account for the economic externalities of impact synergies from related interventions and institutional facilitations. Using Figure 1, we can demonstrate how the welfare gains are missed when impact synergies and institutional roles are ignored. Let us assume that the economy is, again, in status quo at $(i,f)^D$. Suppose that a development intervention, say, an irrigation project, is implemented, leading to a development path represented by the dashed line and the economy attains a new equilibrium at $(i,f)^D$ on the production frontier O'P'. Clearly, the new equilibrium increases the welfare with more food and recreation. Suppose, there is another development program, say, crop intensification which is also implemented either along with or subsequent to the irrigation project. Since crop intensification enhances the welfare impacts of the irrigation-based intervention, the latter can receive considerable development synergies from the former intervention.[5] When these impact synergies are taken into account, we will have a different production frontier and

[4]While the 'dashed' policy intervention is less efficient, it may be politically less controversial, as pressure from individual I (rich) groups may be less due to the fact that the decline in his share is less with 'dashed' policy as compared with the 'solid' policy. Thus, the 'dashed' policy can be the politically feasible policy option.

[5]Notice that the development synergies relate only to the enhanced or reduced welfare effects of the first intervention due to the externalities from the second intervention. As such, they can be both positive and negative. In other words, these synergies capture the difference between the sum of their individual impacts when implemented separately and the joint welfare impacts when implemented and evaluated together.

development path with a new equilibrium, say, at $(i,f)^S$. This new equilibrium, which accounts for the impact synergies, generates higher welfare and more equitable allocation.

In a similar vein, we can also demonstrate the welfare gains from incorporating the role of institutions. If the irrigation-based development intervention is implemented in conjunction with the introduction of a water allocation institution (e.g., rotational water supply or volumetric water allocation), then the production possibility frontier will shift outward and the development path will also change from the dashed line. To minimize notations and complications, let us consider the new production frontier is OP and the development path is the solid line. With this, the equilibrium will move from $(i,f)^D$ to $(i,f)^S$. The difference between the two equilibriums shows the welfare gain of considering the role of institutions in the development process. What is to be noted in the context of impact synergies between development interventions is that although the economy is actually at a higher welfare level, project-based impact assessments are not able to fully account for them. The problem is still more serious in the context of institutional effects because the roles of institutions are not incorporated with proper detail in development planning itself let alone their impact assessment. Admittedly, the welfare effects of impact synergies and institutional roles are not unknown to development planners. But, the reason why they are not addressed in the practical context of development planning relates to methodological problems, especially the analytical and informational difficulties in empirically accounting for them. In this paper, we aim to demonstrate one approach that can overcome these methodological and empirical difficulties by adopting an *ex-ante* approach and stakeholder-based qualitative data.

## The Analytical Framework

The work of Saleth and Dinar (2004) is extended to develop an analytical framework needed for explicitly accounting for the role of institutional impacts and development synergies.[6] The building blocks of this framework are: the *institutional ecology* principle, the *institutional decomposition and analysis* (IDA) approach similar to that of Ostrom (1990), the *ex-ante* approach, and the *adaptive instrumental evaluation* (Tool 1977; Kahneman and Tversky 1984; Bromley 1985). While these concepts are explained in detail by Saleth and Dinar (2004) and briefly in Annex B, here, let us note how they are used to set the analytical framework for evaluating the institution-impact interaction. The institutional ecology principle enables one to view regional or river basin level institutions as a nested and interlinked system embedded within a given physical, social, and political economy context. The IDA framework allows an analytical unbundling of regional or basin institutions (i.e., water, land, agricultural and environmental) to identify their key components; show the structural/functional linkages among them; and trace the relevant institutional configurations operating beneath various impact pathways of different development interventions. As we will show later, the adaptive instrumental evaluation is used to get perception-based *ex-ante* qualitative information from stakeholders.

[6]A general application of this framework for a global ranking of institutional health and reform prospects within the water sector is illustrated in Dinar and Saleth (2005).

## Conceptual Model

The development of the analytical framework begins first with the simple conceptualization of the relationships among the development interventions, institutional configurations, and food security goal. The basic conception of the model of institution-impact interaction is shown in Figure 2. What is more important here is to note how the conceptual model can be operationalized to set the analytical framework of this paper. To operationalize this conceptual model, the original methodology of Saleth and Dinar (2004), which was developed for the particular context of institution-performance interaction within the water sector, requires some important adjustments. In the present context, the adjustments needed are as follows:

First, institutional evaluation should be specialized within a regional context (e.g., river basin or other compact regions), where it is easier to (a) identify relevant development interventions which are completed, ongoing, and planned, (b) trace their major and theoretically possible impact pathways,[7] (c) map all the relevant institutions operating at various points of these impact paths, and (d) evaluate the development impacts and institutional roles in various paths with contextual data and information;

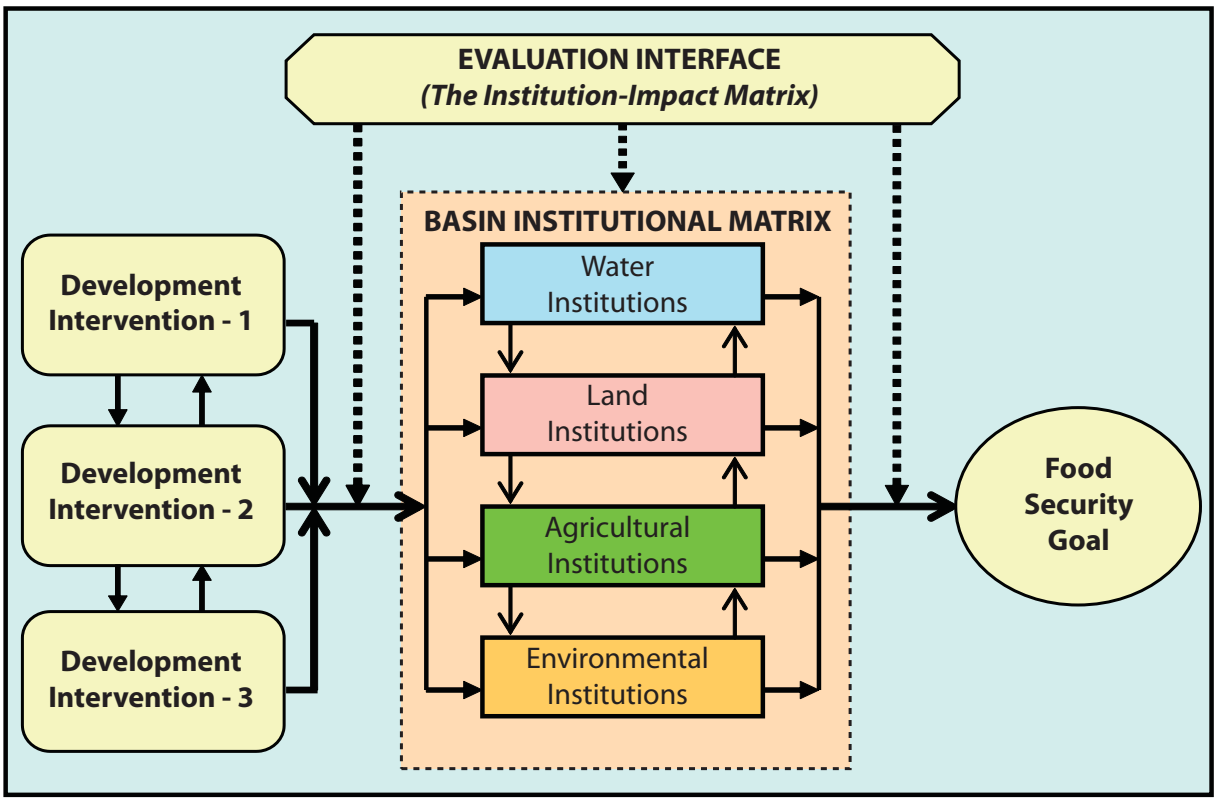



FIGURE 2. Conceptual model for institution-impact interface.

[7]The impact pathways capture the routes through which a development intervention affects the final development goal. These routes can be characterized by a chain of sequentially related development, impact, and institutional variables. For instance, in the case of the food security impacts of an irrigation project, one pathway can be the chain, i.e., cropping intensity-food output-food availability-food prices-food security. Besides this output-related pathway, there is also an income-related pathway, say, cropping intensity-employment-wages-income-food security. We can also construct other similar pathways, where we can also include relevant institutional variables (e.g., production, extension, input, and market institutions, customs and traditions, wage and other labor conditions, price regulations, trade policies, and other rural and economic policies). This will become clear later, especially in the context of Figure 5 (where the pathways are traced and depicted) and in the context of the system model of equations (1) to (21) (where they are formally characterized with development, impact, and institutional variables).

Second, the evaluation is to be extended to cover not just water institutions but also the land, agricultural, rural, and economic institutions within an integrated framework. The focus is as much on the individual performance of these institutions as on their collective performance as evaluated in terms of their structural and operational linkages (North 1990; Saleth and Dinar 2004); and

Third, the evaluation has also to be performed within the framework of a multi-dimensional institution-impact matrix, which captures the impact pathways and their underlying institutions associated with different development interventions and relates the development impacts with the development goals within a functional context. The derivation of this multi-dimensional matrix, including its analytical implications, is illustrated in the following section.

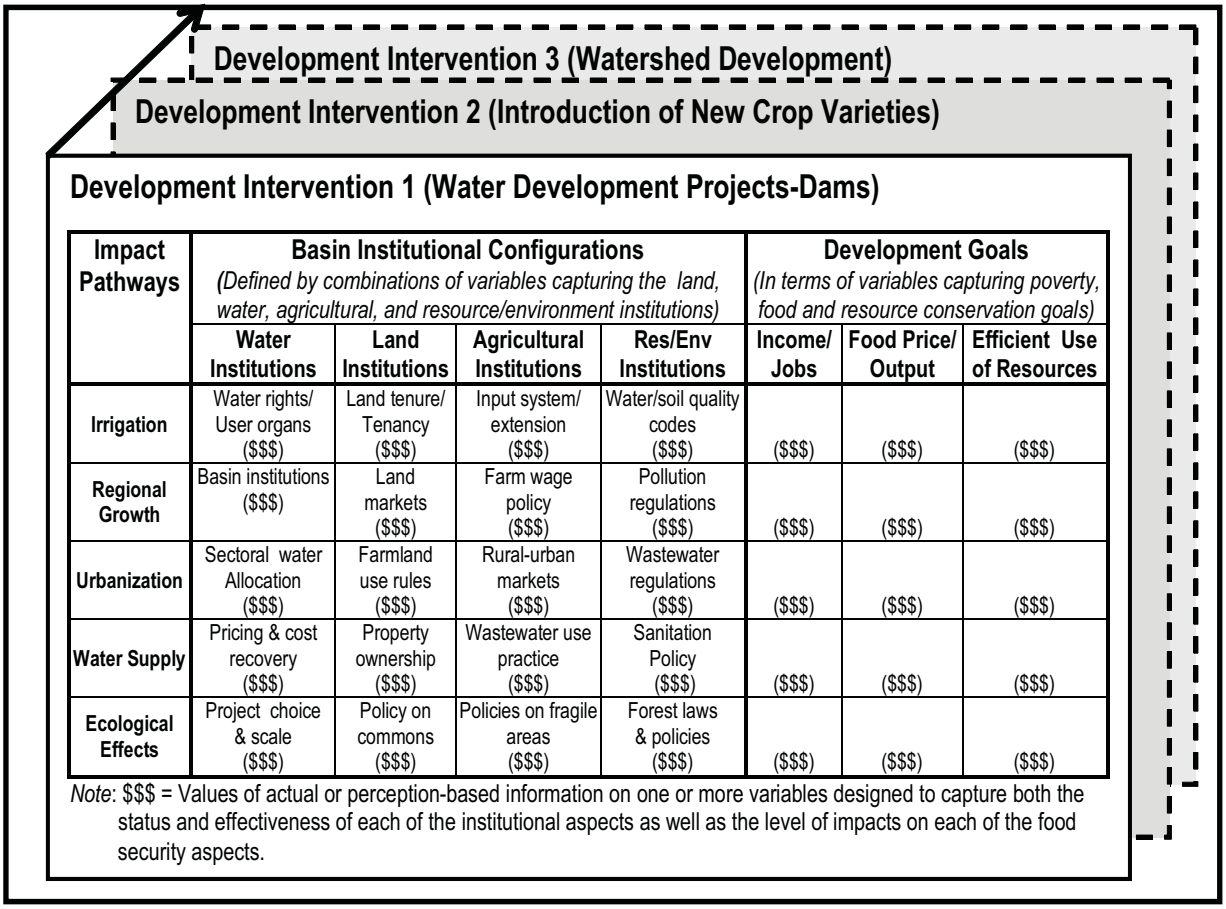
## Institution-Impact Matrix

The institution-impact matrix translates the conceptual model shown in Figure 2 into an operational form. This matrix captures the functional relationships and synergy among development interventions, impact pathways, institutional configurations, and food security goal. To illustrate how this institution-impact matrix can be derived for the context of multiple development interventions, let us take three development interventions, i.e., water development, introduction of new crop varieties, and watershed development for land/soil improvement. These three interventions are related to each other not only in terms of their development synergies but also in terms of their direct or indirect impacts on our candidate development goal, i.e., food security. The next step is to identify the major impact pathways of these three interventions and characterize the possible institutional configurations operating beneath these pathways. Given these impact pathways and their institutional configurations, the next step is to link them with the income, price, and resource components (or the intermediary targets) of the food security goal. As we put them together in a matrix form, as shown in Figure 3, we obtain the required institution-impact matrix. This matrix gives a generic operational form for the conceptual model depicted in Figure 2.

Let us note a few points that will enhance our understanding of the institution-impact matrix. First, it is only to simplify its exposition that the matrix includes only the main impact pathways of the development interventions.[8] Since the impacts in each of these pathways are transmitted through several routes, there will be more than five rows, each with different institutional configurations. Second, the institutional configurations specified for different impact pathways are not exhaustive but only illustrative. It only shows how different institutional configurations are involved in the generation and transmission of impacts passing through the pathways. Third, although the rows in Figure 3 show only the generic institutional aspects, it is possible to identify one or more specific variables to represent these aspects. With such variables as well as the variables underlying various impact routes of the pathways, it is also possible to characterize the interaction between institutional and impact variables.[9] Finally, even

[8]For instance, in the case of water development intervention, we have included only five main paths, though, in reality, each of these paths will affect the development goals through several routes. For instance, the irrigation path will have different but related routes such as production route (i.e., irrigation-cropping intensity-productivity-food supply), income route (irrigation-productivity-employment-income), price routes (irrigation-production-food prices), resource routes (irrigation-waterlogging-salinity-land degradations), etc. Similar routes and the associated chain of variables can also be found for the other four impact paths.

[9]In the impact routes characterized by different chains of variables (see footnote 8), it is possible to include relevant institutional variables. For instance, production, input, and extension-related institutional variables can be added with the impact variables characterizing the production route. Similarly, institutional variables related to market, trade, and price regulation can be added with the impact variables underlying the price route. This will help us to formally and functionally capture the direct and interactive effects of the impact and institutional variables on the intermediary and final goals. We will see this more clearly in the section, *Empirical Specification of the Model*.




| Impact Pathways | Basin Institutional Configurations (Defined by combinations of variables capturing the land, water, agricultural, and resource/environment institutions) | | | | Development Goals (In terms of variables capturing poverty, food and resource conservation goals) | | |
|---|---|---|---|---|---|---|---|
| | Water Institutions | Land Institutions | Agricultural Institutions | Res/Env Institutions | Income/ Jobs | Food Price/ Output | Efficient Use of Resources |
| Irrigation | Water rights/ User organs ($$$) | Land tenure/ Tenancy ($$$) | Input system/ extension ($$$) | Water/soil quality codes ($$$) | ($$$) | ($$$) | ($$$) |
| Regional Growth | Basin institutions ($$$) | Land markets ($$$) | Farm wage policy ($$$) | Pollution regulations ($$$) | ($$$) | ($$$) | ($$$) |
| Urbanization | Sectoral water Allocation ($$$) | Farmland use rules ($$$) | Rural-urban markets ($$$) | Wastewater regulations ($$$) | ($$$) | ($$$) | ($$$) |
| Water Supply | Pricing & cost recovery ($$$) | Property ownership ($$$) | Wastewater use practice ($$$) | Sanitation Policy ($$$) | ($$$) | ($$$) | ($$$) |
| Ecological Effects | Project choice & scale ($$$) | Policy on commons ($$$) | Policies on fragile areas ($$$) | Forest laws & policies ($$$) | ($$$) | ($$$) | ($$$) |

*Note*: $$$ = Values of actual or perception-based information on one or more variables designed to capture both the status and effectiveness of each of the institutional aspects as well as the level of impacts on each of the food security aspects.

FIGURE 3. Institution-impact matrix - a simplified presentation.

though an institutional configuration involved in a given impact pathway is the same, the relative impact of individual institutions in that configuration can be different depending on the three sub-components or intermediary targets of the development goal.

In view of the points noted above, we can see that each row of the matrix implicitly has additional rows representing the various possible impact routes underlying different impact pathways. Since we have three intermediary goals, each of these rows also involves three separate but related relationships. That is, in these relationships, the impact and institutional variables will form the independent variables and the variable(s) representing the three goals will be the dependent variable. In this sense, all the rows corresponding to each of the three development programs can, therefore, be translated into an empirically testable set of relationships (equations), which capture the interactions among the development interventions, existing institutions, the interim impacts, and the ultimate impacts on the final goal. Obviously, the dimension of the matrix or the number of these equations depends on the number of development interventions, the impact pathways and their underlying impact routes, and the sub-goals being considered. This will become clear as we provide an empirical illustration of the application of this framework in a real life context of the Kala Oya Basin in Sri Lanka.

## The Empirical Context: The Kala Oya Basin, Sri Lanka

We apply the institution-impact assessment framework to the institutional and development context of the Kala Oya Basin in Sri Lanka (Figure 4). The Kala Oya Basin, which is one of the 108 basins in Sri Lanka, covers an area of 2,873 square kilometers ($km^2$) and supports a population of about 0.41 million. Of the total land area of 287,303 hectares (ha), far less than a third is cultivable due to land and soil-related problems and water-related constraints. Paddy cultivation and home gardens with coconuts and fruit trees account for 40% of the cultivated area (de Silva et al. 2006). The average farm size is only about one hectare in areas under minor irrigation and dryland farming, and less than half a hectare in areas under major irrigation schemes. Besides, 27% of the population own only the homestead and 11% of the population own neither land nor a homestead (Bandara n.d.). On the demographic side, increasing population density and aging are the main issues.

Water scarcity is also a serious issue due to a low level and seasonal patterns of rainfall as well as groundwater quality problems. The Basin is generally dry for most part of the year with the rainfall ranging from less than 50 millimeters (mm) to about 300 mm. While the high level is observed only during October and November, the low level is observed during February, March, June, July, and August. With an annual local inflow of about 343 million cubic meters (MCM), the basin also receives an annual diversion of about 480 MCM from the Mahaweli system. But, given the total demand of 1,695.28 MCM, there is still a major gap, creating a serious water scarcity problem for the basin (Bandara n.d.; de Silva et al. 2006). The issue is

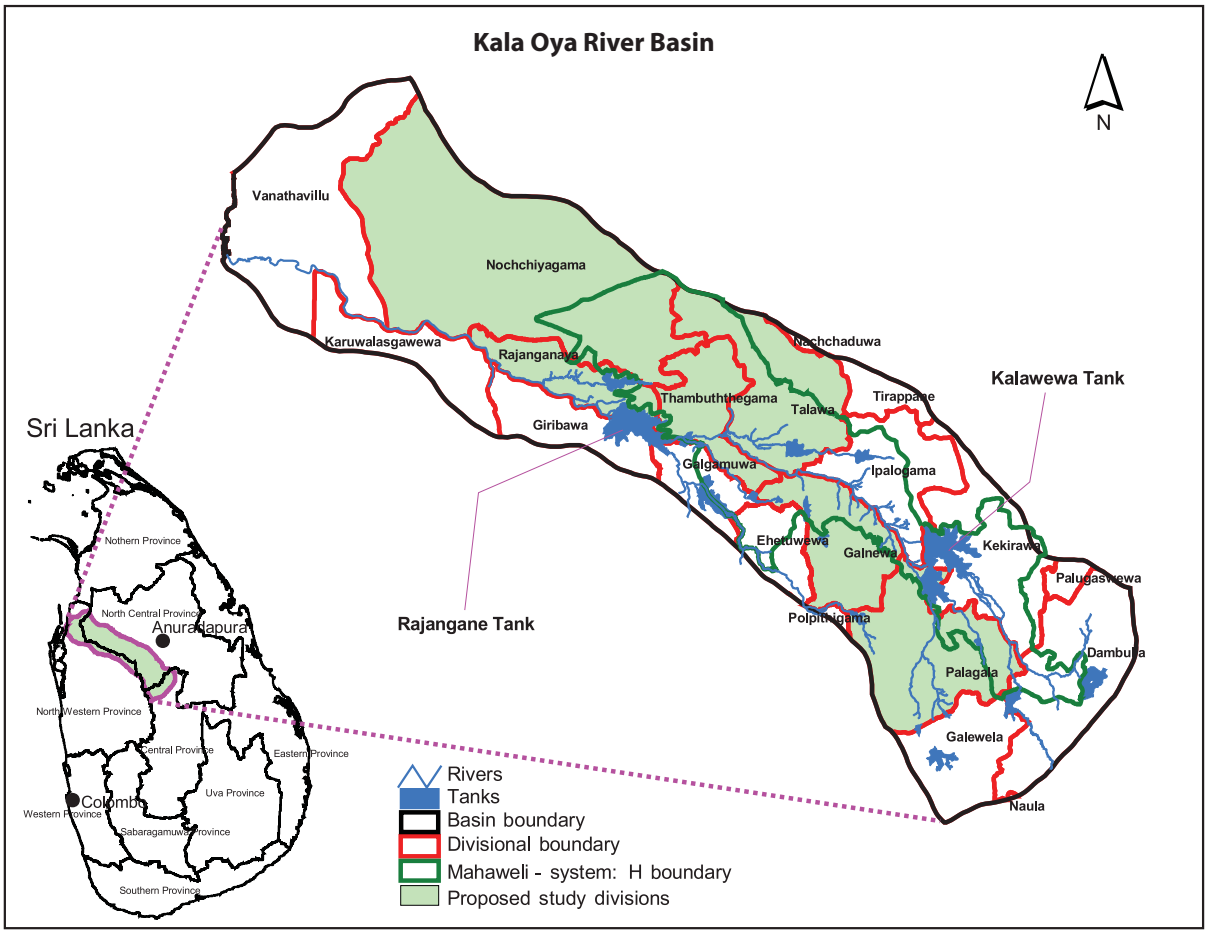



Figure 4. The Kala Oya Basin, Sri Lanka.

further complicated by serious problems of groundwater quality caused by hardness, fluoride, and iron concentration. Only 26% of the groundwater in the basin is completely free from fluoride and 40% of the groundwater is affected by unsafe iron concentration (Bandara n.d.).

The incidence of poverty remains substantial in the basin. For example, in the Anuradhapura District, which accounts for half of the basin area, the percentage of people below the official poverty line (Rs. 1,423 or approximately US$14 per capita/ month) was estimated to be 20% during 2000-2001 (de Silva et al. 2006). In addition, 44% of the families in the basin rely regularly on *Samurdhi,* the poverty reduction program of the government. Food insecurity is also a serious problem, as many villages in the basin area fall under the most vulnerable categories of food insecurity (DCS and WFP 2005). A more detailed review of the basin's poverty level and the strategic reasons for its selection for our case study can be found in Saleth et al. (2006).

## Empirical Specification of the Model

For the empirical translation of the matrix in Figure 3, we need to identify the development goal, development interventions, and the relevant set of institutions. Considering the conditions of the study basin, we take food security related to the hunger reduction target of the first MDG (see Annex A) as the development goal. We consider three development interventions, namely: crop diversification, system rehabilitation and bulk water distribution.[10] It is now possible to trace and delineate the major pathways through which these interventions may impact on food security. Given these impact pathways, it is also possible to identify the set of institutions (i.e., agriculture, water, and land-related legal, policy, and organizational aspects) that are likely to affect the generation and transmission of impacts along and across pathways. Figure 5 depicts these impact pathways and their underlying institutional configurations.

Figure 5 points out the development synergies among the interventions as well as where different institutions influence the impact flows. Although Figure 5 needs to be read from left to right in line with the direction of pathways and impact flows, for analytical convenience, it is useful to move recursively, i.e., starting with the immediate variables affecting food security, and then, tracing back the variables affecting these intermediary variables. In doing so, we could identify the impact pathways and characterize them as relationships using chains of development, institutional, and impact variables.[11] Thus, if we define a set of development, impact, and institutional variables, then, all the institution-impact interactions occurring in various impact pathways and routes depicted in Figure 5 can be mathematically represented as a system of linked equations. To show how this can be done, we define 32 variables listed in Table 1.

[10]Of them, system rehabilitation was already implemented, but bulk water distribution is being implemented only as a pilot in canal areas of the basin. Crop diversification is only being planned, though the Government of Sri Lanka has a national policy to promote diversification.

[11]The impact variables are actually the economic, technical, and physical variables that act as the 'impact transmission variables'. They are not to be confused with those in the impact assessment literature, where 'impact variables' relate only to the ultimate end-goals (see Neubert 2000). In the context of our framework, it is still appropriate to treat them as impact variables because (a) they do capture the intermediary impacts (or outcomes), and (b) such impacts are specifically evaluated using equations representing different impact layers.

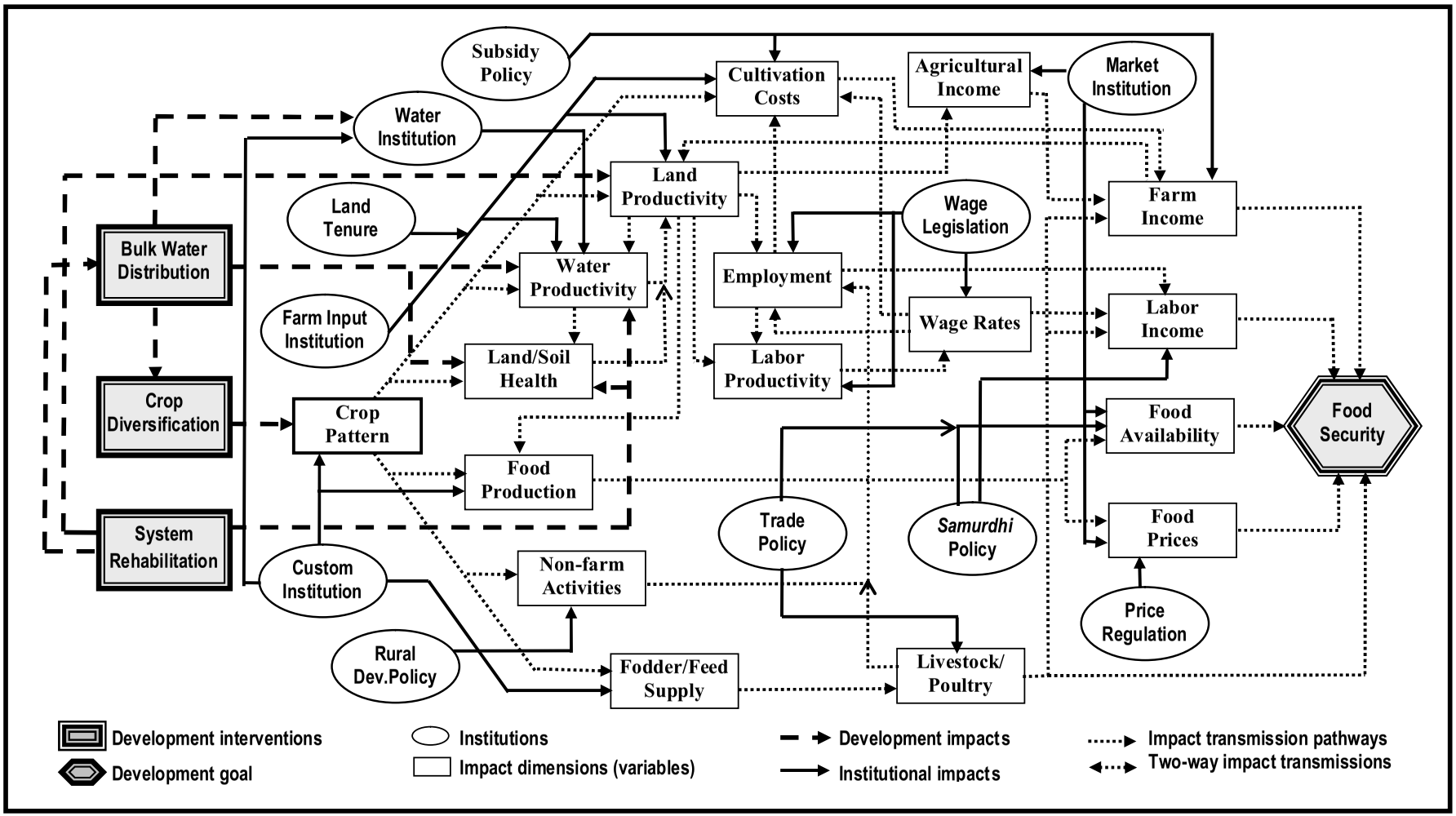



FIGURE 5. Institution-impact system for food security with three development interventions.

TABLE 1. Variables in the institution-impact model.

| Categories of variables | No | Names of variables | Acronym used |
|---|---|---|---|
| Development goal | 1 | Food Security | FOODSECT |
| Development interventions | 1 | Crop Diversification | CROPDIVR |
| | 2 | System Rehabilitation | SYSREHAB |
| | 3 | Bulk Water Distribution | BULKWATD |
| Impact variables | 1 | Crop Pattern | CROPATEN |
| | 2 | Land Productivity | LANPRODY |
| | 3 | Water Productivity | WATPRODY |
| | 4 | Labor Productivity | LABPRODY |
| | 5 | Rural Employment | RURALEMP |
| | 6 | Wage Rates | WAGERATE |
| | 7 | Cultivation Costs | CULTCOST |
| | 8 | Agricultural Income | AGLINCOM |
| | 9 | Land Quality/Soil Health | LANHELTH |
| | 10 | Food Production | FOODPROD |
| | 11 | Non-farm Enterprises | NFAMENTS |
| | 12 | Fodder and Feed Supply | FEDSUPLY |
| | 13 | Livestock/Poultry | LIVSTOCK |
| | 14 | Farm Income | FAMINCOM |
| | 15 | Labor Income | LABINCOM |
| | 16 | Food Availability | FOODAVAL |
| | 17 | Food Price | FOODPRIC |
| Institutional variables | 1 | Land Tenure | LANTENUR |
| | 2 | Water Institutions | WATINSTN |
| | 3 | Farm Input Institutions | FAMINSTN |
| | 4 | Customary Institutions | CUSINSTN |
| | 5 | Rural Development Policy | RDVPOLCY |
| | 6 | Market Institutions | MKTINSTN |
| | 7 | Wage/Labor Legislations | WAGELAWS |
| | 8 | Trade Policy | TRDPOLCY |
| | 9 | Price Regulations | PRICREGL |
| | 10 | Farm Subsidy Policy | SUBPOLCY |
| | 11 | Samurdhi Policy | SAMPOLCY |

As can be seen from Table 1, the variables cover one development goal variable and three intervention variables, 17 impact variables, and 11 institutional variables.[12] Obviously, the variables differ considerably in terms of their unit of measurement, evaluation domain, amenability for observation, and scope for getting actual data. To avoid the problems due to their diverse features, we conceive all the variables essentially in a notional and qualitative sense to be evaluated on an interval of 1-10, with 1 being the lowest and 10 being the highest.[13] In this format, the variables capture only the overall perception of the evaluators (i.e., sample stakeholders) as to their status, change, effectiveness, or impact. For example, the food security variable represents only an overall perception of its overall status considering implicitly, the adequacy and quality of food consumption across income/social groups.[14] Similarly, the variables representing the development interventions are considered to capture their overall effectiveness or impact potential.[15]

Institutional variables capture the status, effectiveness, or impact of institutions with respect to different impact pathways and contexts. For example, the variable LANTENUR captures the conduciveness of land tenure (farm size and ownership) to crop pattern changes, land productivity, etc. The impact variables capture the actual or expected changes due to the impacts of interventions and institutions in different contexts of impact generation and transmission. Among the income variables, a distinction is made between farm income (covering agricultural and livestock incomes) and labor income (covering wage and livestock income) to capture the differential income potentials between those with and without access to land.[16] Given the set of variables listed in Table 1, the institution-impact framework in Figure 5 can be formally represented in a mathematical form with a set of 21 equations that comprise the system model of institution-impact interaction.

It can be verified that each of these equations correspond to one of the 21 impact pathways evident in Figure 5. The equations are structurally linked both sequentially (in most cases) as well as simultaneously (in few cases).[17] The equations are arranged sequentially, starting with the initiation of the development interventions, then, with their impacts in the order of their occurrences, and finally, ending with the impact on the ultimate development goal, i.e., food security. Thus, the order in which the equations are sequenced captures the relative position of different layers within the upstream-downstream continuum of impact transmission. At the same time, the configuration of variables in each equation is based on two considerations: (a) the functional relationship expected between them and the independent variable based on economic concepts, and (b) the need for avoiding linkages among independent variables to minimize the econometric

[12]Notice that the 17 impact variables also include the four variables, i.e., farm income, wage income, food availability, and food price, which are actually the intermediate goals linked immediately with the final goal of food security.

[13]Such an approach also enables us to circumvent the non-availability of data by tapping the knowledge of stakeholders with a carefully designed survey instrument. Note that in the case of quantitative variables (e.g., productivity, income, employment, and food consumption), these scores can be easily converted into quantitative equivalents by using the range of minimum and maximum values observed in the study area. But, in the context of cross-sectional regression and when using with qualitative variables (e.g., the performance and effects of most institutional variables) where performance scores are indispensable, the results will not be qualitatively different whether one uses the scores or their quantitative equivalent for the quantitative variables.

[14]It is considered to be affected by four proximate variables, i.e., income, food prices, food availability, and self-consumption possibilities from homegrown livestock/poultry products.

[15]The major assumption in getting perceptional information in terms of scores is that the sample stakeholders have, more or less, common reference points for their evaluation. These points are related to the minimum and maximum values observed or expected in the case of quantitative variables such as productivity and income, and the best or worst performance observed or expected in the case of qualitative variables such as the status and effectiveness of institutional variables and development programs. This assumption is reasonable if the sample stakeholders are well versed with the economic, technical, and institutional conditions of the region.

[16]Note that unlike the convention in the west where agriculture is defined to include crop and livestock enterprises, here agriculture is defined to cover only crop cultivation.

[17]The simultaneous linkages exist only among the three equations: (5)-(7), where the land and water productivity and the land health variables are to be determined simultaneously.

problem of multicollinearity.[18] Given the functional linkages among variables and sequential linkages among equations, the impact and institutional variables can be hierarchically arranged by tracing their role and positions both within and across the impact pathways.

Of the 32 variables, the 11 underlined variables are independent or exogenous (includes one of the development interventions—SYSREHAB—and all the institutional variables except water institutions—WATINSTN). But, the remaining 21 variables are dependent or endogenous covering 17 impact variables, two development variables representing the two interventions of CROPDIVR and BULKWATD, respectively, and one institutional variable representing WATINSTN. Given the way all the 21 equations are specified in terms of the configuration of endogenous and exogenous variables, they satisfy both the rank and order conditions necessary for their econometric identification and unbiased estimation (Kennedy 1987).[19]

BULKWATD = $f_1$ (SYSREHAB) ..... (1)
CROPDIVR = $f_2$ (BULKWATD) ..... (2)
CROPATEN = $f_3$ (CUSINSTN, CROPDIVR) ..... (3)
WATINSTN = $f_4$ (CUSINSTN, BULKWATD) ..... (4)
LANPRODY = $f_5$ (LANTENUR, CROPATEN, LANHELTH, FAMINSTN SYSREHAB) ..... (5)
WATPRODY = $f_6$ (CROPATEN, LANPRODY, WATINSTN, BULKWATD) ..... (6)
LANHELTH = $f_7$ (CROPATEN, WATPRODY, SYSREHAB, BULKWATD) ..... (7)
FOODPROD = $f_8$ (CROPATEN, LANPRODY, CUSINSTN) ..... (8)
NFAMENTS = $f_9$ (CROPATEN, RDVPOLCY) ..... (9)
LABPRODY = $f_{10}$ (LANPRODY, RURALEMP, WAGELAWS) ..... (10)
WAGERATE = $f_{11}$ (LABPRODY, NFAMENTS, WAGELAWS) ..... (11)
CULTCOST = $f_{12}$ (LANTENUR, CROPATEN, FAMINSTN, WAGERATE, SUBPOLCY) ..... (12)
FEDSUPLY = $f_{13}$ (CROPATEN, CUSINSTN) ..... (13)
LIVSTOCK = $f_{14}$ (FEDSUPLY, TRDPOLCY) ..... (14)
AGLINCOM = $f_{15}$ (LANPRODY, CULTCOST, MKTINSTN) ..... (15)
RURALEMP = $f_{16}$ (LANPRODY, WAGERATE, NFAMENTS, LIVSTOCK, WAGELAWS) ..... (16)
FOODAVAL = $f_{17}$ (FOODPROD, SAMPOLCY, MKTINSTN) ..... (17)
FOODPRIC = $f_{18}$ (FOODPROD, PRICREGL, MKTINSTN) ..... (18)
FAMINCOM = $f_{19}$ (AGLINCOM, CULTCOST, LIVSTOCK, SUBPOLCY) ..... (19)
LABINCOM = $f_{20}$ (RURALEMP, WAGERATE, LIVSTOCK, SAMPOLCY) ..... (20)
FOODSECT = $f_{21}$ (FOODAVAL, FOODPRIC, FAMINCOM, LABINCOM, LIVSTOCK) ..... (21)

[18]These two considerations can be at odds because the economic consideration can warrant the inclusion of one or more independent variables, even though they may be closely related. But, whether this leads to an econometric problem of multicollinearity can be tested using (a) correlation analysis, and (b) indicators such as high $R^2$, low t-ratio, and changing signs of key variables (Gujarati 1995). To test for multicollinearity with our model and date set, we did a correlation analysis of the 32 variables. The correlation matrix showed that only in four cases (SYSREHAB versus BULKWATD and WATINSTN, RURALEMP versus FEDSUPLY, and AGLINCOM versus FAMINCOM) was the correlation coefficient over the suggested threshold of r>0.5 (see Hair et al. 1995). Since they were not used together as independent variables in any equation, the multicollinearity can be taken not to be a serious problem.

[19]The order condition requires that in the case of each equation, the number of excluded exogenous variables is greater than the number of included endogenous variables less one. In simple terms, this condition ensures that there are enough exogenous variables excluded so that they can serve as instrumental variables for estimating the endogenous variable appearing as the dependent variable in each equation. The rank condition, though quite technical, requires, in simple terms, that all the equations are distinct in the sense that none of them can be formed with the linear combinations of any other two equations in the system (Kennedy 1987).

## Data and Results

While the structural model defined by the system of 21 equations is econometrically consistent and intuitively appealing, it has a major empirical challenge because consistent and comparable data on the development, institutional and impact variables are very difficult to obtain. It is certainly possible to acquire observed data on some of the impact variables (e.g., productivity, employment, income, and wage rates) through, for example, published records or a household survey. However, information collected in such a manner will represent only the past impact of an already implemented development intervention and could not capture the synergy from the expected impacts of ongoing and planned intervention. Still more serious are the difficulties in getting the data on the institutional variables, especially on their diverse roles in the generation and transmission of development impacts. It is important to note that since this study involves multiple institutions that transcend sectoral boundaries and vary across provinces, it is essential to select the study area to be entirely within a single jurisdictional boundary. Consequently, the evaluation is confined to the North Central Province, which accounts for 80% of the Kala Oya Basin selected for the study.

### Stakeholder Perceptions as a Data Source

Lack or absence of data on most variables does not, however, mean a complete absence of information on institutional variables and their roles in development implementation. Such information is constantly processed and stored in people involved in the development process either as planners and implementers or as beneficiaries. Therefore, a carefully conducted survey can provide highly relevant information that individuals and society use regularly in making decisions. Such information embodied in individuals is particularly valuable for the analysis of institutional roles and development synergy because it has many desirable properties often missed in observed data. For example, unlike observed data characterizing a past and static situation, the survey data can capture and synthesize objective, subjective, and aspiration-related information. It is also theoretically legitimate in view of the subjective nature of institutions (Commons 1934; Ostrom 1980; Douglas 1986; Ostrom 1990) and the roles that the 'subjective model' of the 'agents of institutional change' play in institutional change and performance (North 1990). As a result, there is a long tradition of using such data for institutional analysis (e.g., Knack and Keefer 1986; Gray and Kaufmann 1998; Barrett and Graddy 2000; Kaufmann et al. 2006). Qualitative data are also used even in cases such as impact assessment (Neubert 2000; Coudouel et al. 2006).

Perceptions can be used as an evaluation mechanism not only to synthesize variables in different domains but also to operationalize 'adaptive instrumental evaluation', where the outcomes are evaluated in positive and relative terms with respect to reference points that are not static but change with learning and expectations (Tool 1977; Kahneman and Tversky 1984; Bromley 1985). In view of these properties, perception-based information is similar in format and quality to those derived from alternative non-market data generation techniques such as 'Delphi', 'Contingent Valuation', and 'Stated Preference' (Saleth and Dinar 2004). It is on the strength of these theoretical and practical considerations that this paper uses the stakeholder-based *ex-ante* qualitative information as a basis for the empirical evaluation of the model of institution-impact interactions.

Understandably, the empirical approach used in this paper is underpinned by two inter-related facts that: (a) practically valuable information on the status and performance of institutions and on the spread and intensity of development impacts are constantly processed, updated, coded, and used in various forms and in many impact assessments and decision-making; and (b) such real, but latent, information can be obtained with innovative procedures that explicitly recognize the central role of stakeholders both as change agents and as

information source for the evaluation of institutional impacts and development synergies. Thus, the two key components of the empirical approach are 1) the selection of a suitable sample of stakeholders, and 2) the elicitation of their perception-based information for all the variables in the structural model.

The sample of stakeholders selected for data collection includes 67 persons, who are directly involved in development planning, implementation, and evaluation in the Kala Oya Basin.[20] The sample covers government officials at different levels (32), researchers/academics (32), and farmers/ community leaders (3).[21] The names of the respondents are listed in Annex C. To collect the information on all the 32 variables included in the model, a special survey instrument was developed and administered to the sample of stakeholders in May 2006. The survey instrument is included as Annex D. It shows how different variables are defined and how the data on them were derived from the answers to one or more questions. In most cases, the values of the variables were obtained as the average of the values for the related questions. Table 2 presents the descriptive statistics for the 32 variables.

## Model Results and Institution-Impact Analysis

Assuming different specifications and functional forms for the equations and using the stakeholder-based qualitative information for the model variables, first, we performed the specification test suggested by Hausman (1978) to identify the more appropriate specification for the model.[22] Since this test suggested that the specification with linear form and constant term yields more efficient and consistent estimates, we have adopted this specification for the model. With the same specification, we have also estimated two versions of the model of institution-impact interaction mainly to demonstrate the more realistic way for capturing the role of institutions in the process of impact generation and transmission. The first is a single equation model, where food security is postulated as a simple linear function of all the remaining 31 development, institutional, and impact variables. This simple model captures the conventional approach, which assumes away the specifics and dynamics of institution-impact interaction. The second version is the system model, which specifically captures the mechanics of impact generation and transmission in terms of 21 equations linked both sequentially and simultaneously. By comparing the two models and their results, we can show both the realistic way of modeling and evaluating the process of institution-impact interaction as well as the specific points in the impact pathways where different institutions have their influence on and interaction with other impact variables.

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[20]Notably, these stakeholders, though knowledgeable about the region and its development process, are not all necessarily from the study region or are the direct beneficiaries of the development interventions.This is partly to avoid the potential bias and partly to address the macro-micro dichotomy evident in empirical impact evaluation literature, i.e., micro evaluations report considerable impact whereas macro evaluations find little or no impact, or vice versa (Neubert 2000; Coudouel et al. 2006).

[21]Considering the technical nature of the analytical framework and the nature of the questions, the original plan was to cover only the government officials and experts in the sample. However, in the end, we also tried to test whether the questionnaire can be administered to farmers and community leaders. This is how the three farmers and community leaders were added to the sample. Since the experience shows that farmers and community leaders are able to understand and answer the questions well, the present exercise can very well be repeated with a sample exclusively of farmers and local leaders.

[22]Essentially, the Hausman test checks econometrically whether the estimates of the coefficients of a model obtained from two different estimation procedures (i.e., different specifications, functional forms, and data transformations) differ significantly or not. In our case, this test was used to compare four models with different specifications and functional forms, i.e., linear form with constant term, linear form without the constant term, log-linear form with constant terms, and log-linear form without the constant term.

TABLE 2. Descriptive statistics for the model variables.

| Variables | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|
| FOODSECT | 5.07 | 1.59 | 0.75 | 8.00 |
| CROPDIVR | 6.04 | 1.79 | 2.00 | 10.00 |
| SYSREHAB | 6.75 | 1.19 | 1.67 | 8.83 |
| BULKWATD | 6.32 | 1.75 | 1.00 | 9.00 |
| CROPATEN | 5.60 | 1.00 | 2.79 | 7.57 |
| LANPRODY | 6.84 | 1.40 | 2.63 | 10.00 |
| WATPRODY | 7.29 | 1.42 | 4.00 | 10.00 |
| LABPRODY | 4.94 | 2.21 | 1.00 | 9.00 |
| RURALEMP | 5.31 | 2.08 | 1.00 | 10.00 |
| WAGERATE | 6.10 | 1.27 | 2.50 | 8.50 |
| CULTCOST | 5.66 | 1.68 | 1.00 | 8.00 |
| AGLINCOM | 6.90 | 1.49 | 3.00 | 10.00 |
| LANHELTH | 7.62 | 1.33 | 3.50 | 10.00 |
| FOODPROD | 5.22 | 1.23 | 2.33 | 7.67 |
| NFAMENTS | 7.07 | 1.29 | 2.25 | 9.50 |
| FEDSUPLY | 5.32 | 1.43 | 1.00 | 8.00 |
| LIVSTOCK | 3.64 | 1.62 | 0.90 | 7.90 |
| FAMINCOM | 5.50 | 1.09 | 3.00 | 9.00 |
| LABINCOM | 4.64 | 1.31 | 2.00 | 8.00 |
| FOODAVAL | 5.24 | 1.36 | 2.50 | 8.50 |
| FOODPRIC | 4.37 | 1.31 | 1.50 | 7.50 |
| LANTENUR | 6.20 | 1.15 | 3.56 | 8.33 |
| WATINSTN | 5.03 | 1.88 | 1.00 | 9.00 |
| FAMINSTN | 5.52 | 1.68 | 1.00 | 9.00 |
| CUSINSTN | 4.71 | 1.28 | 1.40 | 7.60 |
| RDVPOLCY | 5.07 | 1.85 | 1.50 | 9.00 |
| MKTINSTN | 5.10 | 1.35 | 1.67 | 9.33 |
| WAGELAWS | 3.51 | 1.74 | 1.00 | 8.50 |
| TRDPOLCY | 6.57 | 1.41 | 3.00 | 9.00 |
| PRICREGL | 4.62 | 1.57 | 1.00 | 8.75 |
| SUBPOLCY | 6.82 | 1.38 | 3.00 | 10.00 |
| SAMPOLCY | 5.12 | 1.97 | 1.00 | 10.00 |

As to the estimation procedure, the single equation model was estimated using the Ordinary Least Squares (OLS) method whereas the system model was estimated using the Three Stage Least Squares (3SLS) approach. The OLS results of the single equation model, which captures the conventional approach to institution-impact interaction, are provided in Annex E. Since the single equation model postulates the development, institutional, and impact variables to directly influence food security, it is not able to characterize the actual paths and mechanics of the interactions and impacts. Consequently, as can be seen from Annex E, the OLS results show that none of the institutional variables is statistically significant and neither do the variables represent the three development interventions. Even among the 17 impact variables, only five are significant at the level of 20% or better. These significant impact variables are: LABPRODY, WAGERATE, AGLINCOM, FAMINCOM, and LABINCOM. Notably, all of them, except AGLINCOM, have the expected positive effect. The negative effect of AGLINCOM, especially given the positive effect of FAMINCOM, is clearly inconsistent with expectations, as it suggests a negative association

between agricultural income and food security. This inconsistency taken with the insignificance of institutional and development variables clearly suggests the potential for serious anomalies when a single equation model is used to describe the reality of a complex set of sequential and simultaneous interactions among the model variables. This problem gets more serious when the roles of institutions are treated superficially or exogenously missing the reality of their intricate and endogenous role within the development process.

In contrast, the system model results, which is based on 3SLS approach and presented in Table 3, demonstrate the policy insights that can be derived with a more realistic treatment of institutions, especially considering their mediating roles both in the generation and transmission of development impacts. The key aspect to note from Table 3 is the way both the institutional influence and the development impact are transmitted across the equations. The operational mechanisms for such transmissions are obviously the sequential and simultaneous interactions that occur among the development, institutional and impact variables. Our interpretation of the results follows the equations to show how the dependent variables in the intermediate equations capture and transmit both the development and institutional impacts into the ultimate development goal of food security. We will also show the relative magnitude and statistical significance of different institutional and impact variables and indicate possible weak spots and missing links both within and across the impact pathways.

TABLE 3. System model of institution-impact interaction: 3SLS results.

| Equation number | Dependent variable | Independent variables | Estimated coefficient[b] | T-ratio | Elasticity at means[c] |
|---|---|---|---|---|---|
| (1) | BULKWATD | Constant | 0.754 | 1.053 | 0.120 |
| | | SYSREHAB | **0.824** | 8.002 | 0.881 |
| (2) | CROPDIVR | Constant | **7.690** | 7.186 | 1.272 |
| | | BULKWATD | ***-0.261*** | -1.574 | -0.272 |
| (3) | CROPATEN | Constant | **3.621** | 4.085 | 0.646 |
| | | CUSINSTN | **0.362** | 4.482 | 0.305 |
| | | CROPDIVR | 0.045 | 0.433 | 0.049 |
| (4) | WATINSTN | Constant | -0.352 | -0.341 | -0.070 |
| | | CUSINSTN | -0.032 | -0.229 | -0.030 |
| | | BULKWATD | **0.876** | 6.006 | 1.100 |
| (5) | LANPRODY | Constant | -0.625 | -0.349 | -0.091 |
| | | LANTENUR | ***0.154*** | 1.491 | 0.139 |
| | | CROPATEN | 0.263 | 0.912 | 0.215 |
| | | LANHELTH | **0.721** | 2.863 | 0.802 |
| | | FAMINSTN | **0.150** | 1.812 | 0.121 |
| | | SYSREHAB | ***-0.189*** | -1.496 | -0.187 |
| (6) | WATPRODY | Constant | -1.065 | -0.506 | -0.146 |
| | | CROPATEN | **-1.668** | -2.762 | -1.282 |
| | | LANPRODY | **1.991** | 4.213 | 1.869 |
| | | WATINSTN | -0.291 | -1.063 | -0.201 |
| | | BULKWATD | **0.877** | 2.611 | 0.760 |
| (7) | LANHELTH | Constant | **2.861** | 1.853 | 0.375 |
| | | CROPATEN | **1.146** | 3.748 | 0.843 |
| | | WATPRODY | -0.220 | -0.769 | -0.210 |
| | | SYSREHAB | **1.041** | 3.150 | 0.923 |
| | | BULKWATD | **-1.123** | -4.315 | -0.930 |

*(continued)*

TABLE 3. System model of institution-impact interaction: 3SLS results. (Continued)

| Equation number | Dependent variable | Independent variables | Estimated coefficient[b] | T-ratio | Elasticity at means[c] |
|---|---|---|---|---|---|
| (8) | FOODPROD | Constant | **-1.628** | -1.922 | -0.312 |
| | | CROPATEN | **0.892** | 4.844 | 0.958 |
| | | LANPRODY | **0.276** | 1.938 | 0.361 |
| | | CUSINSTN | -0.008 | -0.106 | -0.007 |
| (9) | NFAMENTS | Constant | 0.115 | 0.085 | 0.016 |
| | | CROPATEN | **1.098** | 5.049 | 0.870 |
| | | RDVPOLCY | **0.159** | 2.262 | 0.114 |
| (10) | LABPRODY | Constant | **-0.749** | -0.355 | -0.152 |
| | | LANPRODY | 0.378 | 1.090 | 0.523 |
| | | RURALEMP | **0.429** | 2.205 | 0.462 |
| | | WAGELAWS | ***0.234*** | 1.894 | 0.167 |
| (11) | WAGERATE | Constant | **4.621** | 3.497 | 0.757 |
| | | LABPRODY | **0.256** | 2.110 | 0.207 |
| | | NFAMENTS | -0.032 | -0.169 | -0.037 |
| | | WAGELAWS | ***0.126*** | 1.572 | 0.073 |
| (12) | CULTCOST | Constant | **2.977** | 1.646 | 0.526 |
| | | LANTENUR | 0.107 | 0.456 | 0.117 |
| | | CROPATEN | -0.234 | -0.459 | -0.231 |
| | | FAMINSTN | 0.015 | 0.092 | 0.015 |
| | | WAGERATE | 0.714 | 1.081 | 0.770 |
| | | SUBPOLCY | -0.163 | -1.025 | -0.197 |
| (13) | FEDSUPLY | Constant | 1.221 | 0.971 | 0.229 |
| | | CROPATEN | **0.444** | 1.609 | 0.468 |
| | | CUSINSTN | **0.343** | 2.420 | 0.303 |
| (14) | LIVSTOCK | Constant | **8.702** | 8.283 | 2.401 |
| | | FEDSUPLY | **-0.916** | -4.553 | -1.346 |
| | | TRDPOLCY | -0.030 | -0.282 | -0.055 |
| (15) | AGLINCOM | Constant | 0.656 | 0.438 | 0.095 |
| | | LANPRODY | **0.522** | 2.092 | 0.518 |
| | | CULTCOST | **0.366** | 2.204 | 0.301 |
| | | MKTINSTN | 0.117 | 0.939 | 0.086 |
| (16) | RURALEMP | Constant | ***10.912*** | 1.392 | 2.054 |
| | | LANPRODY | **1.049** | 1.850 | 1.351 |
| | | WAGERATE | **-1.363** | -2.130 | -1.566 |
| | | NFAMENTS | 0.034 | 0.057 | 0.046 |
| | | LIVSTOCK | **-1.306** | -2.158 | -0.891 |
| | | WAGELAWS | 0.009 | 0.054 | 0.006 |
| (17) | FOODAVAL | Constant | -0.316 | -0.275 | -0.060 |
| | | FOODPROD | **0.908** | 3.586 | 0.904 |
| | | SAMPOLCY | -0.031 | -0.407 | -0.031 |
| | | MKTINSTN | ***0.192*** | 1.574 | 0.187 |
| (18) | FOODPRIC | Constant | -1.166 | -1.100 | -0.267 |
| | | FOODPROD | **0.697** | 3.096 | 0.831 |
| | | PRICREGL | **0.154** | 2.070 | 0.163 |
| | | MKTINSTN | **0.234** | 2.197 | 0.273 |

*(Continued)*

TABLE 3. System model of institution-impact interaction: 3SLS results. (Continued)

| Equation number | Dependent variable | Independent variables | Estimated coefficient[b] | T-ratio | Elasticity at means[c] |
|---|---|---|---|---|---|
| (19) | FAMINCOM | Constant | **2.441** | 2.454 | 0.444 |
| | | AGLINCOM | **0.560** | 5.196 | 0.702 |
| | | CULTCOST | **-0.265** | -3.180 | -0.273 |
| | | LIVSTOCK | ***0.142*** | 1.468 | 0.094 |
| | | SUBPOLCY | 0.027 | 0.523 | 0.033 |
| (20) | LABINCOM | Constant | -2.398 | -0.664 | -0.517 |
| | | RURALEMP | 0.125 | 0.831 | 0.143 |
| | | WAGERATE | 0.301 | 0.953 | 0.396 |
| | | LIVSTOCK | **1.043** | 3.006 | 0.815 |
| | | SAMPOLCY | **0.148** | 2.107 | 0.163 |
| (21) | FOODSECT | Constant | ***3.688*** | 1.371 | 0.728 |
| | | FOODAVAL | 0.244 | 0.809 | 0.253 |
| | | FOODPRIC | **-0.924** | -2.845 | -0.798 |
| | | FAMINCOM | ***0.755*** | 1.517 | 0.819 |
| | | LABINCOM | 0.026 | 0.067 | 0.024 |
| | | LIVSTOCK | -0.036 | -0.091 | -0.025 |
| **System $R^2$ [c]** | | | | | **0.685** |

*Notes*: [a] Bold coefficients are significant at 10% or better. Bold and italicized coefficients are significant at 11-20%.

[b] Elasticity at means are the weighted coefficients with the weights being the ratio of the means of the concerned dependent and independent variables. This standardization enables a comparison of the relative importance of the independent variables both within and across equations.

[c] The System $R^2$ in the case of 3SLS estimation captures the explanatory power of the whole model.

The system as a whole explains 68% of the variation in the independent variables, which can be taken as reasonably higher given the nature of the cross-section regression performed here. To begin with, the result for equation (1), which postulates the relationships between two development interventions: SYSREHAB and BULKWATD, shows that the intervention related to water infrastructural improvement has a statistically significant and positive effect on the intervention aimed at improving the institutional dimension of water distribution. The results provide evidence for development synergy and for the influence of development on institutional performance. The same can also be seen in equation (2), where BULKWATD has a statistically significant negative effect on CROPDIVR, suggesting that the institution-related development intervention of bulk water distribution tends to reduce the prospects for crop diversification.[23] Apart from the infrastructural and institutional constraints, there are also other difficulties, especially those emerging from customary tendencies in crop choice. The results for equation (3) clearly show that customary institutions (CUSINSTN)[24] are more powerful than the economic and technical prospects for diversification (CROPDIVR) in determining the crop pattern (CROPATEN). Even though BULKWATD has not promoted crop diversification, it has a strong positive effect on water institutions, especially by strengthening farmer associations and promoting better water distribution. This is also clear from the results of equation (4).

[23]The result is not surprising because the policy of providing bulk water to farmer groups has not solved the basic issue of volumetric allocation to individual farmers yet, which is essential for independent crop decisions.

[24]As can be seen from the question 25 of the questionnaire in Annex D, customary institutions relate to the roles of customs and traditions, which are considered particularly in the context of crop choice, water allocation, and maintaining common grazing lands.

Equation (5) provides statistical evidence for the relative role of physical, agronomic, and institutional factors in determining land productivity. As the results show, although the soil fertility and land health (LANHELTH) is the most dominant factor, institutional factors such as the FAMINSTN covering the extension and input supply systems and LANTENUR encompassing the tenure security are also important in influencing land productivity. Notably, the development intervention of SYSREHAB has direct negative effect on land productivity, though, as we will see in equation (7), it has an indirect but statistically more significant positive effect via LANHELTH.[25] Equation (6) shows that water productivity is influenced positively by land productivity whereas only negatively by the crop pattern.[26] While the water institution is not at all significant as a determinant of water productivity, bulk water policy has a significant positive effect on the same. Equation (7) shows that of the four variables, SYSREHAB and CROPATEN are both significant and have the expected positive impacts on LANHELTH. But, the behavior of the other variables (BULKWATD and WATPRODY) seems to be somewhat spurious.[27]

Turning to equation (8), the variables having the significant positive impacts on FOODPROD are the CROPATEN and LANPRODY. It shows clearly that the level of food production is determined by the food crop-dominated cropping pattern as well as the productivity of land, which actually captures the positive impacts of the institutional and physical variables such as land security, farm institutions, and soil fertility, as shown in equation (5). Interestingly, in equation (9), even though the crop pattern is dominated by food crops, it has a significant positive effect on the prospects for non-farm enterprises. This is partly due to the fact that most non-farm activities observed in the region are linked to the processing and marketing of food crops, especially paddy. But, active rural development policy also contributes to the growth and diversification of rural non-farm activities. Equation (10) shows that the level of labor productivity is determined not by land productivity but primarily by the level of rural employment and by the wage rate and working conditions as influenced by the prevailing rural wage laws and regulations in the region. This is not surprising because with similar cropping patterns and productivity levels, land productivity, unlike the other factors, may not explain much of the variation in labor productivity. This view is reinforced by equation (11), where labor productivity and rural wage laws are the dominant factors determining the wage rates. It should also be noted that NFAMENTS, the variable capturing non-farm prospects, does not significantly affect farm wage rates. This is, in part, due to the weak status of non-farm activities and the lack of workers moving between the farm and non-farm sectors.

In the case of equation (12), none of the factors postulated to affect cultivation costs is significant, even though the wage rates and the subsidy policy are relatively more important and have the expected positive and negative effect, respectively. In equation (13), CROPATEN and CUSINSTN have a positive and statistically significant effect on the potential for fodder and feed supplies (FEDSUPLY). The domination of food crops, especially paddy, contributes to feed supply in terms of crop residues whereas customary institutions contribute in terms of open grazing and biomass collection. But, the results for equation (14) suggest that the feed supply potential is not the primary factor explaining the prospects for livestock development (LIVSTOCK). As a result, livestock development can be lower even with a

[25]This is an important aspect of development impacts. Simple and one-dimensional approaches to impact assessment may miss not only the relative magnitude and directions of impacts transmitted in multiple channels and pathways but also the role and influence of the institutions, which are operating across all these channels and pathways.

[26]This negative effect is understandable in view of the crop pattern in the region being dominated by food crops, which, as explained in the context of previous equations, is due to a strong role of customs in crop choice and the poor prospect for crop diversification.

[27]Since BULKWATD has a significant negative effect on LANHELTH whereas WATPRODY is not at all significant, there seems to be the problem of multicollinearity among them. In fact, as we have seen in equation(6), there is a strong positive association among them. But, as explained in footnote 18, such positive association is not serious enough to cause the multicollinearity problem.

higher potential for feed and fodder supply, implying a negative association between the two.[28] Equation (15) shows that income from crop cultivation (AGLINCOM) is influenced positively by both land productivity and cultivation cost.[29]

In equation (16), only three of the five variables postulated to affect rural employment are statistically significant. Of these, land productivity has a positive effect, but wage rates and livestock development have a negative effect. The inverse association between wage rates and rural employment implies both the high levels of wage rates and labor scarcity in the study area. *Samurdhi*, the government's poverty alleviation program, has not had much of an effect on food availability, though, as we will see in equation (20), it does have a significant role in augmenting labor income. Equation (17) models the association that food price has with food production as well as with the two institutions, price regulations and the market system. The results for equation (17) are intuitively consistent as they show that food availability in the market is positively influenced by food production on the one side and distribution-related market institutions on the other side. However, it can be seen that the production side plays a relatively stronger and more dominant role. The results show that in equation (18) all three variables are significant with a positive effect suggesting that food prices continue to rise despite increasing production, procurement-related price regulations, and market expansion. This suggests that market expansion and price regulations have not effectively moderated food prices.

Equations (19) and (20) evaluate the relative size and direction of the effects of factors determining farm and labor incomes, respectively. Although the income from agricultural operations has the dominant positive effect on farm income, that from livestock is also significant. Interestingly, cultivation cost, which had a positive effect on agricultural income in equation (15), now has a significant negative effect on farm income. Among the significant factors affecting labor income, livestock remains dominant, though the government's poverty alleviation program of *Samurdhi* also has an important effect. Finally, equation (21) is the last equation in the system, and it captures the various direct and indirect effects of development, impact, and institutional variables that flow through the intermediate equations. The results of this equation are very interesting because they show that food price rather than its availability is more important. This means that, from the perspective of promoting food security, the factors affecting food prices such as food production and the associated institutions in production, marketing, and distribution are very important. Similarly, the result that farm income has a positive and dominant effect on food security as compared with labor income suggests that food security is stronger among people with access to land than among those without that access. The insignificance of the livestock variable suggests that the food security role of self-consumption from homegrown livestock/poultry products (e.g., milk, egg, and meat) is not very important.

The comparison of OLS and 3SLS model results show how important it is to look into the micro relations among development, institutional, and impact variables, which are operating beneath the overall impact generation and transmission process. Unlike the OLS results, the 3SLS results were able to shed light not only on the significant roles of various institutional variables but also on the linkages among the development and impact variables in the specific context of different impact pathways and layers. The results of the individual equations actually show the layer-specific roles of and relations among the development, institutional, and impact variables. The first two equations provide some quantitative evidence for the synergies among the development interventions. Similarly, the other equations provide evidence for

[28]The undeveloped potential of livestock and the poor utilization of available feed/fodder observed in the study region are clearly consistent with the result obtained here.

[29]The positive effect of CULTCOST, unlike that of LANPRODY, is somewhat unexpected, particularly, given the prevailing concern in the study region about the income implications of the rising cost of cultivation. However, the result suggests that agricultural income is rising in the face of increasing costs, thanks to the possible neutralizing role of increasing land productivity.

the layer-specific roles of institutional and impact variables. In view of the structural linkages among the model equations, the development synergies and the institutional impacts also flow through the system and are finally captured by food security, the ultimate dependent variable in the system. But, it is important to note that as development synergies and institutional impacts flow through the system, they can be magnified, neutralized, or even distorted by the role of other variables interacting in subsequent equations. With the system model and its results, it is possible to get more insights into this internal dynamics of the impact transmission process.

The internal dynamics of the impact transmission process can be evaluated both analytically and numerically using a reduced form single equation for the system model. The reduced form equation can be formed using the structural linkages among the equations. This equation, unlike the OLS model, explicitly captures the functional and sequential linkages among all the model variables, as represented by the 21 equations. By plugging the 3SLS results into the reduced form equation and taking derivatives with respect to all the policy-sensitive variables in the model, one can perform a sensitivity analysis that will shed light on how the marginal effects flow and get transformed through the system. Numerical analysis of the flow of these effects can be a basis for identifying the weak links within the impact transmission process, including the development, institutional, and impact variables involved therein. The same analysis can also rank the variables in terms of the magnitude of their marginal impacts on the intermediate variables and final goal. Although work on the sensitivity analysis is still going on, preliminary results do suggest that in terms of the marginal effects on food security, market institution has the highest effect, followed by others such as price regulation and trade policy. Unlike these institutions with a positive effect, there are others with a negative contribution such as land tenure and rural development policy.

## Conclusions and Implications

This paper has argued that though the impact synergies among development interventions and the impact enhancing role of institutions, are well known, they are not being taken into account in actual development planning, implementation, and evaluation. This problem has far reaching implications, especially for meta-development goals such as MDGs, which require effective institutions and an integrated approach to development planning and implementation. It is demonstrated graphically how an insufficient treatment of the impact enhancing role of institutions can lead to substantial welfare loss and how the ignorance of the impact synergies among past, ongoing, and planned interventions leads to biased impact assessment. To help address these serious problems, this paper has presented one approach for developing an analytical framework and evaluation methodology and also illustrated it in the empirical context of the Kala Oya Basin in Sri Lanka, using stakeholder-based qualitative information.

The analytics of the institution-impact framework shows both the specific point at which different institutions influence the impact generation and transmission process as well as the mechanics of impact synergies among the past, ongoing, and planned interventions. The mathematical representation of this framework, when compared with the normally used single equation model, provides additional insights into the functional relations among the development, institutional, and impact variables and the sequential linkages among the impact pathways. For policy purposes, a better understanding of all these analytics, mechanics, and linkages are

valuable because they can help package and sequence interventions, and identify and strengthen the major impact transmission paths and their underlying institutions.

Despite the preliminary nature of the model and the qualitative nature of the information, the results, especially those from the comparison of single equation and system models, do provide considerable insights into the roles that institutions play in the generation and transmission of impacts across impact pathways as well as the impact synergies that development interventions derive from others. These development synergies are captured not only by the coefficients of the variables representing the development interventions but also those of other impact and institutional variables because these synergies flow though the system through their direct and indirect effects. As a result, these synergies, in fact, make the institutional evaluation more complex but rich because they provide the scope for considering the linkages between institutional and impact variables within the process of development. Since the regression results are, in effect, the statistical representation of the consensus prevalent among the selected stakeholders, there is ample support for most of the relations postulated by the system model. Since the system model unbundles the impact process and deciphers its transmission channels, it is able to both capture the flow and direction of development impacts and to show which institutions affect what channel. These are valuable information for policy design, institutional analysis, and impact assessment.

From the perspective of policy design, the results suggest that when planning an intervention in a given region, it is critical to consider the potential synergies possible from past, ongoing, and planned interventions. In our study region, for example, the implementation of system rehabilitation has had a substantial facilitating impact on the performance of bulk water distribution, and this positive synergy has the potential to enhance the prospects for crop diversification. The results also indicate that the synergy among the interventions can be enhanced with a fine-tuning of the laws, policies, and organizations related to the land, water, agriculture, market, and trade spheres. Although the institutions covered here are not exhaustive, the results do show that among the institutions considered, those operating in the production and marketing spheres are relatively more important in terms of their role in channeling the impacts to the ultimate goal of food security. Specifically, since food prices and farm income are the most dominant factors affecting food security, all their intermediary variables and their underlying institutions (e.g., market, price regulation, land tenure, and credit and extension) are very important.

Besides the production-related farm institutions and distribution-related market institutions, there are also major influences from national level policies and laws such as those related to farm subsidy, rural industrialization, poverty alleviation, and wage rates and working conditions. At the same time, customary institutions related to cultivation practices and common grazing lands have significant effects on crop choice and livestock development. Notably, customary tendencies towards paddy cultivation, though a serious constraint for crop diversification, have a positive effect on the supply side of food security. To what extent changes in the performance of these rural institutions could affect the ultimate goal can, in fact, be evaluated in terms of chain functions capturing how a marginal change in any of the institutions leads to a series of changes within the equation systems and culminates finally in the marginal change in food security. Similarly, how impact synergies among development interventions contribute to the final goal can also be evaluated in terms of the marginal changes in one or more of the variables characterizing various impact chains. Sensitivity analysis of this nature can provide valuable information for policymakers in prioritizing institutions and sequencing development interventions. While the methodology is intuitive and the results provide insights, we also recognize some of the limitations and scope for further refinements, especially those related to the specification and structuring of the equations. For example, the insignificance of all the variables in

equation (12) makes it redundant and, hence, creates a gap in the system. Either this equation has to be re-specified or excluded from the system. Similarly, the unexpected signs of some variables, insignificance of crucial variables in some equations, and the inclusion of variables with a strong association as independent variables in the same equation are problems that can be avoided with a more refined set of equations. From an empirical perspective, although only the perception-based qualitative data are used here to provide an empirical demonstration of evaluation approach, it is possible to explore ways for using observed and quantitative data from secondary sources and household surveys for as many variables as possible. In this case, a mix of quantitative and qualitative data can be used to estimate the model. Given the preliminary nature of the analytical framework and empirical approach, some of the analytical, empirical, and econometric limitations are only to be expected at this stage. Obviously, there is a considerable scope for refinement and extensions both on the analytical and empirical fronts, which can be explored well in future work. Despite its current limitations, the paper has still succeeded both in highlighting two of the most serious problems in current development planning, implementation, and assessment, i.e., the impact synergies and institutional roles, and also providing an empirical illustration of an analytical framework and evaluation methodology that can be useful to deal with these problems in practical contexts.

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# Annex A.
# The Millennium Development Goals and Targets

**Goal 1: Eradicate extreme poverty and hunger**
- Reduce by half the proportion of people living on less than a dollar a day
- Reduce by half the proportion of people who suffer from hunger

**Goal 2: Achieve universal primary education**
- Ensure that all boys and girls complete a full course of primary schooling

**Goal 3: Promote gender equality and empower women**
- Eliminate gender disparity in primary and secondary education preferably by 2005, and at all levels by 2015

**Goal 4: Reduce child mortality**
- Reduce by two thirds the mortality rate among children under five

**Goal 5: Improve maternal health**
- Reduce by three quarters the maternal mortality ratio

**Goal 6: Combat HIV/AIDS, malaria and other diseases**
- Halt and begin to reverse the spread of HIV/AIDS
- Halt and begin to reverse the incidence of malaria and other major diseases

**Goal 7: Ensure environmental sustainability**
- Integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources
- Reduce by half the proportion of people without sustainable access to safe drinking water
- Achieve significant improvement in lives of at least 100 million slum dwellers, by 2020

**Goal 8: Develop a global partnership for development**
- Develop further an open trading and financial system that is rule-based, predictable and non-discriminatory, includes a commitment to good governance, development and poverty reduction – nationally and internationally
- Address the least developed countries' special needs. This includes tariff- and quota-free access for their exports; enhanced debt relief for heavily indebted poor countries; cancellation of official bilateral debt; and more generous official development assistance for countries committed to poverty reduction
- Address the special needs of landlocked and small island developing states
- Deal comprehensively with developing countries' debt problems through national and international measures to make debt sustainable in the long term
- In cooperation with the developing countries, develop decent and productive work for youth
- In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries
- In cooperation with the private sector, make available the benefits of new technologies – especially information and communications technologies

*Source*: http://www.un.org/millenniumgoals/index.html

*Note*: The reference point for the targets is 1990 and the target date for achieving most goals and targets is 2015.

# Annex B.
# Technical Notes

***Institutional Ecology Principle*:** This principle extends the 'ecosystem' concept to institutional systems to analytically show (a) the linkages and synergies among institutions across domains (law, policy, and organization), spheres (land, water, agricultural, rural, and environmental), and scales (basin, region, and national), and (b) the nested and embedded character of institutions within the social, economic, political, and resource systems.

***Institutional Decomposition and Analysis Framework*:** This framework unbundles institutions into a set of interrelated rules, characterizes them using quantitative and qualitative variables, and formalizes the relations and linkages among these rules (Saleth and Dinar 2004). The approach is similar in spirit to the Institutional Analysis and Development framework developed by Ostrom (1990) for application to local level institutions for common pool resources management.

***Ex-ante Approach*:** This approach tries to evaluate the futuristic changes and expectation aspects related to institutions based on the convergence in stakeholders' perception. Such consensual perception can summarize objective evaluation, learned judgments, aspirations, and expectations of participating stakeholders. Unlike the *postmortem* approach underlying the *ex-post* evaluation and analysis, the *ex-ante* approach is very useful for designing anticipatory and coping strategies that would allow enough lead time for policy/program adjustments and modifications.

***Adaptive Instrumental Evaluation*:** Unlike other evaluation approaches in economics relying on normative and absolute concepts such as 'efficiency' based on the assumption of individual rationality and perfect information, the adaptive instrumental evaluation is based on a positive and relative approach (Tool 1977; Kahneman and Tversky 1984; Bromley 1985). It allows the evaluation of events/aspects with respect to relevant reference points (e.g., best practices, desirable conditions, and stated objectives) rather than ideals or absolute conditions. It also allows the reference points to be flexible and changeable within the evaluation process itself (Saleth and Dinar 2004). This approach is very pertinent for evaluating aspects such as institutions and their performance involving considerable level of qualitative and subjective considerations.

# Annex C.
# List of Experts/Stakeholders in the Sample

| | Name | Professional position |
|---|---|---|
| 1 | K. A. Upali S. Imbulana | Director (Water Resources) |
| 2 | H. P. S. Somasiri | Additional Secretary (Irrigation) |
| 3 | H. P. Somathilaka | Assist Director (Planning) |
| 4 | Wasantha Ekanayake | Director (Lands and Development) |
| 5 | E. Wijepala | Senior Executive (Additional Secretary) |
| 6 | G. D. Perera | Director (Agriculture) |
| 7 | Neil Bandara | Project Director (PEACE Project) |
| 8 | Christy Perera | Deputy Director (Agricultural Extension) |
| 9 | W. M. M. U. R. Mahakumbura | Deputy Director (Horticultural Research) |
| 10 | R. A. D. Jayanthie | Chartered Engineer |
| 11 | W. L. W. Premadasa | Resident Project Manager (INMAS) |
| 12 | N. Samaratunga | Irrigation Engineer |
| 13 | L. S. Fernando | Irrigation Engineer |
| 14 | Eng. D. M. N. Janaka Dhanapala | Civil Engineer |
| 15 | Ananda Jayasinghe | Additional Director, Agronomy, IMD |
| 16 | H. M. B. Karunaratne | Farmer |
| 17 | W. A. N. A. Wijesinghe | Civil Engineer (Water Resources Development) |
| 18 | Lalitha Seneviratne | Deputy Resident Project Manager (Technical Services) |
| 19 | Ms. O. P. Prematilaka | Deputy Manager (Natural Resources), Kala Oya Basin |
| 20 | Ranjith Premalal de Silva | Senior Lecturer |
| 21 | Lakshman Galgedara | Senior Lecturer |
| 22 | Dr. B. V. R. Punyawardena | Head, Agro-climatology Division, Dept. of Agriculture |
| 23 | Dr. R. S. K. Keerthisena | Research Officer |
| 24 | K. M. Seneviratne Banda | Research Officer |
| 25 | M. A. K. Munasinghe | Research Officer |
| 26 | A. Sellahewa | Deputy Director (Water Management), MASL |
| 27 | M. Weerasinghe | Sri Lanka Administrative Service |
| 28 | J. A. S. A. Jayasinghe | Director, Kala Oya Basin Secretariat |
| 29 | H. H. Padmasiri Premakumara | Kala Oya River Basin Manager |
| 30 | Dr. S. Pathmarajah | Senior Lecturer |
| 31 | Sisirakumara Mohotti | Rural Sector Community Dev. Consultant |
| 32 | N. Indrasenan | Director (Plan Implementation) |
| 33 | Dr. S. Thiruchelvam | Senior Lecturer in Resource Economics |
| 34 | Dr. L. H. P. Gunaratne | Senior Lecturer |
| 35 | Susil Premaratne | Agrarian Services Development Officer |
| 36 | W. M. P. B. Wijesooriya | Divisional Secretary (DS) |
| 37 | K. T. Dayaratne | Chairman, Lift Irrigation Farmers' Cooperative |
| 38 | Premadasa Kaluarachchi | President, Tract 01 Farmer Organization |
| 39 | S. D. M. Rajapaksa | Institutional Development Officer, IMD, Rajangana |
| 40 | J. M. J. B. Jayawardena | Divisional Officer (Agrarian Development Office) |
| 41 | S. B. Niyangoda | Chair, Sri Lanka Water Partnership |
| 42 | Dixon Nilaweera | Regional Coordinator, GWP-SAS, Regional Office |
| 43 | Lalith Dassenaike | Regional Manager – IWMI |
| 44 | Mrs. Anula Indrani | Divisional Secretary (DS) |
| 45 | W. G. A. W. Gamage | Agriculture Research and Produce Assistant (APRS) |
| 46 | Mr. N. B. Muthubanda | Agrarian Development Officer |
| 47 | R. M. Samanthilaka Ratnayaka | Secretary Farmer Organization (Farmer) |
| 48 | K. Wijeweera | APRS |

*(continued)*

Annex C. (Continued)

| | Name | Professional position |
|---|---|---|
| 49 | Ranjith Ariyaratne | Benchmark Basin Coordinator, IWMI |
| 50 | D. J. Bandaragoda | Senior International Consultant |
| 51 | K. Jinapala | Researcher, IWMI |
| 52 | Sarath Abayawardana | Head, Sri Lanka Program, IWMI |
| 53 | Ranjith Ratnayake | Ex-Director, Water Resources, Ministry of Irrigation |
| 54 | Madar Samad | Principal Researcher, IWMI |
| 55 | Nilantha Gamage | Remote Sensing/GIS Specialist, IWMI |
| 56 | P. G. Somaratne | Senior Research Officer |
| 57 | Deeptha Wijeratne | Agricultural Economist/Research Officer, IWMI |
| 58 | Priyantha Jayakody | Research Officer, IWMI |
| 59 | R. W. Kulawardhana | Remote Sensing/GIS Specialist, IWMI |
| 60 | P. B. Dharmasena | Deputy Director (Research) |
| 61 | Sampath Abeyrathne | Research Officer, IWMI |
| 62 | Upali Amarasinghe | Researcher, IWMI |
| 63 | N. Abeywickrama | Senior Adviser, IWMI |
| 64 | A. M. Jabir | Free Lance Consultant |
| 65 | M. Jehanathan | Assistant Director (Agriculture) |
| 66 | A. P. Keerthipala | Principle Research Officer, Sugar Research Institute |
| 67 | R. S. Kulathunga | Deputy Conservator of Forests |

# Annex D.
# Survey Instrument

**Study on the**
**Institutional Assessment for Food Security**
**in the Kala Oya Basin, Sri Lanka**

(Research preparation work funded by World Bank and IWMI)

## Survey Instructions

(1) The conceptual framework is generic, but captures as much as possible the relevant aspects of Kala Oya Basin (KOB) in particular and Sri Lanka in general.

(2) It is focused on the impact of the three development programs on food security, particularly from the perspective of small farmers, farm workers, and the other rural poor.

(3) 'Impact pathways' are the routes through which the economic impacts of development interventions are transmitted to the development goals. These impact transmissions are carried out by the 'impact variables'. In the present context, three development interventions (i.e., crop diversification program; system rehabilitation, and bulk water allocation policy) and one development goal (i.e., food security) are considered.

(4) Before asking questions, the conceptual framework is briefly explained to give adequate background for the respondents. First, the three development interventions and their role in food security, then, their impact pathways defined by the impact variables, and, finally, the role of institutional factors in effecting these pathways are all explained to them.

(5) The respondents are also informed that the questions to be asked are related to different components of the framework and answers are expected with respect to the conditions prevalent in KOB in particular and Sri Lanka in general.

(6) More importantly, it is necessary to convince them that the evaluation is done in an *ex-ante* context and what they perceive or believe about various relationships in the conceptual framework is very important and valuable for the evaluation and analysis. Also, it is important to inform them that the development programs can be both those that are implemented as well as those that are contemplated or potentially relevant for the KOB or Sri Lanka.

All questions are formulated as 'yes' or 'no' questions or questions requiring answers within the scale of 1-10, with '1' being low or weak and '10' being high or strong, depending on the context. For coding purposes, a 'no' answer is treated as 0 and the 'yes' answer is evaluated within the scale of 1-10. Thus, all answers are recorded within the scale of 0-10.

## PART - A
## Basic Details

(1) Respondent's Details:

(a) Name .....

(b) Qualification .....

(c) Discipline .....

(d) Professional Position .....

(e) Years of Experience .....

(f) Contact Details .....

.....

.....

.....

Email .....

(2) Interview Details:

(a) Interviewer's Name .....

(b) Place and Date .....

# PART–B
# Detailed Questionnaire

1. Food Security (FOODSECT)
   - (a) How strong, in your opinion, is the food security status of small farmers? ☐
   - (b) How strong, in your opinion, is the food security status of farm workers? ☐
   - (c) How strong, in your opinion, is the food security status of the rural poor? ☐
   - (d) How strong, in your opinion, is the nutritional status of children and the aged? ☐

2. Crop Diversification (CROPDIVR)
   *(From low to high-value crops; e.g., paddy to vegetables, oilseeds, and fruits)*
   - (a) How bright are the economic and technical prospects for crop diversification? ☐
   - (b) How effective are the crop diversification efforts of the government? ☐
   - (c) How important are customs in crop choice? ☐
   - (d) How serious are customs in constraining crop diversification? ☐
   - (e) How important is water delivery system for crop diversification? ☐
   - (f) How serious is small farm size as a constraint for crop diversification? ☐
   - (g) How important is land and soil quality as a factor for crop diversification? ☐

3. System Rehabilitation (SYSREHAB)
   - (a) How effective is the system rehabilitation program? ☐
   - (b) How far can rehabilitation improve land and soil health (by limiting salinity)? ☐
   - (c) How important is system rehabilitation as a contributing factor for land productivity? ☐
   - (d) How far system rehabilitation is effective in facilitating bulk water allocation? ☐

4. Bulk Water Distribution (BULKWATD)
   - (a) How far can bulk water distribution improve existing water allocation procedures? ☐
   - (b) How far can bulk water distribution strengthen water user organizations? ☐
   - (c) How far can bulk water distribution contribute to crop diversification? ☐
   - (d) How far can bulk water distribution improve water use efficiency? ☐
   - (e) How far can bulk water distribution contribute to land and soil health? ☐

5. Crop Pattern (CROPATEN)
   - (a) To what extent can crop diversification alter crop pattern? ☐
   - (b) How far can diversification lead to the adoption of high-value crops? ☐
   - (c) How far can the changes in crop pattern lead to water savings? ☐
   - (d) Haw far can the changes in crop pattern improve land and soil health (via crop rotation)? ☐
   - (e) How far can the changes in crop pattern negatively affect foodgrain output? ☐
   - (f) How far can the changes in crop pattern negatively affect fodder/feed supply? ☐
   - (g) How far can the changes in crop pattern raise cultivation costs? ☐
   - (h) If crop pattern shifts towards high-value crops, how important is this shift for the development of rural non-farm activities? ☐

6. Land Productivity (LANPRODY)
   *(Output per unit of land; it differs by crops)*
   - (a) How important is land productivity for farm employment? ☐
   - (b) How important is land productivity for farm income? ☐
   - (c) How important is land productivity for labor productivity? ☐
   - (d) Generally, higher land productivity leads to higher water productivity. How strong will this relationship between land and water productivity be? ☐
   - (e) Crop pattern changes, though reducing the area under food crops, can also improve the overall farm productivity. If so, how significant will this effect be? ☐
   - (f) System rehabilitation and bulk water delivery can improve water delivery and contribute, thereby, to overall farm land productivity. If so, how significant will this effect be? ☐

7. Water Productivity (WATPRODY)
*(Output per unit of applied water; it differs depending on crops)*

Generally, efficient water use contributes to land productivity, partly by minimizing the negative effects of water over use (e.g., waterlogging; salinity) and partly by enhancing the efficiency and productivity of other farm inputs. If this is so,

(a) How strong will the impact of water use efficiency on land productivity be? ..... ☐

(b) How strong will the impact of water use efficiency be on the efficiency of other inputs? ..... ☐

8. Labor Productivity (LABPRODY)
*(Output per labor; it differs by crops)*

(a) Generally, higher labor productivity will lead to higher wage rate. If so, how strong (or weak) ..... ☐
is the relationship between labor productivity and wage rates? ..... ☐

(b) Generally, efficient and productive workers do the same or more work. If so, how important is the role of productivity in determining the overall level of farm employment? ..... ☐

9. Rural Employment (RURALEMP)

(a) Generally, given the level of land productivity, more employment means less labor productivity. If so, how strong is this negative relationship? ..... ☐

(b) Generally, for given wage rates, more employment means more income. But, with low or declining wage rates, more employment may not always lead to more income. How relevant and realistic is this fact? ..... ☐

10. Wage Rates (WAGERATE)

(a) How strong is the influence of higher wage rates on cultivation costs? ..... ☐

(b) Are the wage rates high enough to provide incentives for improved labor productivity? If so, how strong will this effect be? ..... ☐

(c) Are the wage rates adequate enough to assure decent income for farm workers? If so, how strong will this fact be? ..... ☐

11. Cultivation Costs (CULTCOST)

(a) Obviously, increasing cultivation costs reduce agricultural income. But, the issue is whether additional costs due to crop diversification are high enough to affect the farm income of small farmers. If so, how serious is this cost effect on farm income? ..... ☐

(b) At the same time, the additional costs due to diversification can also be smaller in relation to the additional income from the same. If so, how important is this fact for crop choice? ..... ☐

12. Agricultural Income (AGLINCOM)

(a) While farm income is a necessary condition for food security, other non-income factors (e.g., food price and supply, its quality and composition, and family size) are also important. Given this, how important is the relative role of income in ensuring food security? ..... ☐

13. Land Quality/Soil Health (LANHELTH)

(a) How important is land and soil health for land productivity, especially in the long-run? ..... ☐

(b) How important is the land and soil health for flexible crop choice? ..... ☐

14. Food Production (FOODPROD)

(a) Normally, higher food production means more food supply in the market. But, export, procurement, and hoarding can reduce food availability. If so, how serious is this effect? ..... ☐

(b) Similarly, higher food output means low food prices for consumers. But, the factors noted above may act against such price decline. If so, how serious is this effect? ..... ☐

15. Non-farm Enterprises (NFAMENTS)
*(e.g., small enterprises, petty trade, handicrafts, services)*

(a) Does labor scarcity affect farm wage rates? If so, how significant is this effect? ..... ☐

(b) How important are non-farm activities for rural employment? ..... ☐

(c) Do non-farm activities create farm labor scarcity? If so, how serious is this effect? ..... ☐

16. Fodder and Feed Supply (FEDSUPLY)
*(e.g., rice straw, husks, and other farm by-products)*

(a) How important is the role of agriculture in supplying fodder and feed? ..... ☐

(b) Does change in crop pattern (say from paddy to vegetables or oilseeds) affect fodder supply? If so, how serious will this negative effect be? ..... ☐

(c) If the farm families with livestock rely on green fodder from public grazing lands and home gardens, crop pattern changes do not matter much. How realistic is this fact? ..... ☐

17. Livestock/Poultry (LIVSTOCK)
*(This does not relate to commercial enterprises, but only to those maintained by rural families)*

(a) How important are livestock and poultry for self-employment? ..... ☐

(b) How important are livestock and poultry as an income source for small farmers? ..... ☐

(c) How important are livestock and poultry as an income source for farm workers and the poor? ..... ☐

(d) How important are livestock and poultry for the family consumption of milk and meat? ..... ☐

(e) How important are livestock and poultry for the nutritional security of the children and the aged? ..... ☐

18. Farm Income (FAMINCOM)

(a) How food-secure are the small farmers? ..... ☐

(b) Is this security due to their cultivating food (paddy) crops? If so, how realistic is this fact? ..... ☐

(c) Does this food security role of food (paddy) crops act against crop diversification? If so, how realistic is this fact? ..... ☐

19. Labor Income (LABINCOM)

(a) How adequate are the wage income of rural workers to assure their food security? ..... ☐

(b) How critical are the livestock and non-farm income sources for rural workers and the poor? ..... ☐

20. Food Availability (FOODAVAL)

(a) How adequate is food availability to assure food security for rural workers and the poor? ..... ☐

21. Food Price (FOODPRIC)

(a) How affordable are food prices to rural workers and the poor? ..... ☐

22. Land Tenure (LANTENUR)
*(Farm size; tenure security)*

(a) How important is farm size for adopting improved farm technologies and practices? ..... ☐

(b) How important is tenure security for adopting improved farm technologies and practices? ..... ☐

(c) How important is land titles in securing farm credits? ..... ☐

(d) How serious are small farms as constraints for efficient water delivery? ..... ☐

(e) Are smaller farms more efficient in water use? If so, how realistic is this fact? ..... ☐

(f) Generally, small farms are unable to benefit from scale economies. If so, how serious is this fact in affecting their cultivation costs? ..... ☐

23. Water Institutions (WATINSTN)
*(Water release policy; allocation procedures)*

(a) How flexible is the water release policy for promoting diverse crops? ..... ☐

(b) How suitable are the existing water allocation practices for efficient water use? ..... ☐

24. Farm Input Institutions (FAMINSTN)
*(Credit, farm inputs, and extension institutions)*

(a) How effective and accessible is the farm credit system for small farmers? ..... ☐

(b) How effective and accessible are the fertilizer and seeds supply systems for small farmers? ..... ☐

(c) How effective and accessible is the farm extension system for small farmers? ..... ☐

(d) Are the farm input supply systems, including credit, too costly for small farmers? If so, how serious is this problem? ..... ☐

(e) Are the farm input supply systems, including credit, focused on particular crops (e.g., paddy or coconut)? If so, how serious is this as a constraint for crop diversification? ..... ☐

25. Customary Institutions (CUSINSTN)
*(Local customs, conventions, traditions, and informal rules*)

(a) Normally, farmers' choice of food or traditional crops (e.g., paddy) is thought to be influenced by customary practices. If so, how limiting are local customs for crop diversification? ..... ☐

(b) How influential are local customs and conventions in water allocation and use decisions? ..... ☐

(c) Are there strong traditions in maintaining local commons as grazing areas for livestock? ..... ☐

26. Rural Development Policy (RDVPOLCY)

(a) How effective are state policies in promoting rural non-farm activities? ..... ☐

(b) Are there special programs for developing specific non-farm enterprises (e.g., handicrafts; food processing units)? If so, how effective are they? ..... ☐

27. Market Institutions (MKTINSTN)

(a) How effective are the agricultural markets in providing the right prices for farmers? ..... ☐

(b) How important is the role of traders and middlemen in the marketing of farm outputs? ..... ☐

(c) How effective are markets in stabilizing harvest and post-harvest price fluctuations? ..... ☐

(d) How effective is the procurement policy in supporting farm prices? ..... ☐

28. Wage/Labor Legislations (WAGELAWS)
*(Legislations on wage rates and working conditions)*

(a) How effective are the minimum wage legislations in guiding rural wage rates? ..... ☐

(b) How strong are local customs and social pressures in influencing rural wage rates? ..... ☐

(c) How effective are the special legal provisions (e.g., child labor; minimum working hours) in affecting rural labor supply and employment? ..... ☐

29. Trade Policy (TRDPOLCY)
*(Farm import and export policies)*

(a) Do the trade policies on the import of milk and meat products limit livestock and poultry development? If so, how serious is this constraint? ..... ☐

(b) Do the trade policies on the import of food products add to domestic food availability? If so, how important is this policy for food and nutritional security? ..... ☐

30. Price Regulations (PRICREGL)

(a) How effective are price regulations in controlling the food prices for consumers? ..... ☐

(b) Do price regulations distort agricultural markers? If so, how serious is this effect? ..... ☐

31. Farm Subsidy Policy (SUBPOLCY)
*(Fertilizer and credit subsidies)*

(a) Are there subsidies for fertilizers and farm credits? If so, how effective are they in controlling cultivation cost? ..... ☐

(b) Do these subsidies have a favorable effect on farm income? If so, how significant are they for farmers? ..... ☐

32. *Samurdhi* Policy (SAMPOLCY)
*(Special state program for poverty alleviation)*

(a) How effective is the ***Samurdhi*** policy in supporting the income of the rural poor? ..... ☐

(b) How effective is the ***Samurdhi*** policy in improving the food availability to the rural poor? ..... ☐

# Annex E.
# OLS Results for the Single Equation Model

| Dependent variable | Independent variables | Estimated coefficient | T-Ratio | Level of significance | Standardized coefficient | Elasticity at means | $R^2$ |
|---|---|---|---|---|---|---|---|
| FOODSECT | BULKWATD | 0.317 | ***1.485*** | 0.146 | 0.349 | 0.395 | 0.447 |
| | SYSREHAB | -0.053 | -0.152 | 0.880 | -0.040 | -0.070 | |
| | CROPDIVR | -0.038 | -0.251 | 0.803 | -0.043 | -0.045 | |
| | CROPATEN | -0.267 | -0.652 | 0.519 | -0.168 | -0.295 | |
| | WATINSTN | 0.255 | ***1.351*** | 0.185 | 0.302 | 0.253 | |
| | WATPRODY | 0.013 | 0.056 | 0.955 | 0.011 | 0.018 | |
| | LANHELTH | -0.212 | -0.864 | 0.393 | -0.177 | -0.318 | |
| | LANPRODY | -0.135 | -0.459 | 0.649 | -0.119 | -0.182 | |
| | FEDSUPLY | 0.124 | 0.554 | 0.583 | 0.111 | 0.130 | |
| | LIVSTOCK | -0.111 | -0.633 | 0.531 | -0.116 | -0.080 | |
| | NFAMENTS | 0.057 | 0.258 | 0.798 | 0.047 | 0.080 | |
| | LABPRODY | 0.253 | ***1.606*** | 0.117 | 0.353 | 0.247 | |
| | WAGERATE | 0.506 | ***1.752*** | 0.088 | 0.407 | 0.610 | |
| | RURALEMP | 0.077 | 0.475 | 0.637 | 0.101 | 0.081 | |
| | CULTCOST | 0.125 | 0.715 | 0.479 | 0.132 | 0.140 | |
| | AGLINCOM | -0.785 | ***-2.707*** | 0.010 | -0.737 | -1.068 | |
| | FAMINCOM | 1.128 | ***2.910*** | 0.006 | 0.776 | 1.225 | |
| | LABINCOM | 0.452 | ***1.907*** | 0.065 | 0.373 | 0.414 | |
| | FOODPROD | -0.118 | -0.342 | 0.735 | -0.092 | -0.122 | |
| | FOODAVAL | 0.125 | 0.487 | 0.629 | 0.107 | 0.129 | |
| | FOODPRIC | -0.215 | -0.898 | 0.375 | -0.177 | -0.185 | |
| | LANTENUR | -0.139 | -0.613 | 0.544 | -0.101 | -0.170 | |
| | CUSINSTN | -0.102 | -0.402 | 0.690 | -0.082 | -0.095 | |
| | FAMINSTN | -0.129 | -0.618 | 0.540 | -0.137 | -0.141 | |
| | MKTINSTN | -0.253 | -1.184 | 0.244 | -0.215 | -0.255 | |
| | PRICREGL | -0.003 | -0.020 | 0.984 | -0.003 | -0.003 | |
| | WAGELAWS | -0.053 | -0.256 | 0.800 | -0.058 | -0.037 | |
| | RDVPOLCY | 0.107 | 0.634 | 0.530 | 0.126 | 0.108 | |
| | TRDPOLCY | 0.184 | 0.729 | 0.471 | 0.164 | 0.239 | |
| | SUBPOLCY | -0.134 | -0.720 | 0.476 | -0.117 | -0.180 | |
| | SAMPOLCY | 0.173 | 0.876 | 0.387 | 0.215 | 0.175 | |

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