Economic calculations for assessing agricultural systems
Cost benefit analysis and farm level real budget analysis

Eric Penot*1, Bénédicte Chambon*2, Theingi Myint*3

*1 CIRAD, UMR INNOVATION, F-34398 Montpellier, France.
INNOVATION, University of Montpellier, CIRAD, INRAE, Institut Agro, Montpellier, France.
*2 CIRAD, UMR ABSys, Yangon, Myanmar.
ABSys, CIRAD, INRAE, l'Institut Agro, CIHEAM, Montpellier, France.
*3 Yezin Agricultural University,Department of Agricultural Economics, Nay Pyi Taw, Myanmar

Introduction

The economic assessment of agricultural systems is a necessary step in understanding peasant practices and in the creation and dissemination of innovative systems.

There are many different definitions, each with its pros and cons, of the various economic criteria that have to be taken into account. It therefore becomes essential to adopt precise definitions for the various economic terms used and to clearly lay down the conventions of calculating them.

This proposal for the harmonization of economic calculations is based on a document produced within the ambit of various projects for the dissemination of techniques of direct-seeding mulch-based cropping systems (DMC or CA for conservation agriculture) in Madagascar.[1] It has been adapted for use in the Generating Rubber Opportunities project (GRO project) in Myanmar[2]. It is based on real farm budget analysis, taking into account in and out money flows, real costs and calculation of gross and net margin.

The definitions and calculation conventions adopted are those usually recognize in Europe as standard for farm economics analysis. However, the adoption of common definitions /conventions is an essential prerequisite for being able to compare data originating from different sources. Moreover, the definitions/conventions adopted here are compatible with the farm modelling tool used (Olympe) and are traditionally used in the management sciences.

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[1] Penot E, Husson O, Rakotondramanana, 2010. *Les bases de calculs économiques pour l'évaluation des systèmes SCV. Manuel pratique de semis direct à Madagascar. Annexe 2.* CIRAD, GSDM, AFD, FFEM, Ministère de l'Agriculture.

[2] The authors of this adapted version would like to thank Generating Rubber Opportunities in Myanmar (GRO) project for supporting the translation from French to English. GRO is a project of the Swiss Agency for Development and Cooperation (SDC) implemented by CARE International in Myanmar.

This document presents the various economic indicators used for comparing farming systems and for assessing farmer incomes. Simple examples are used to illustrate definitions and calculation conventions and reference is made to the corresponding settings/variables in the Olympe software.

1. Definition of the economic indicators used

In order to simplify the calculations and the presentation of the results, we propose the use of the following indicators for assessing family farms.

Gross Product
Gross product is the value of gross agricultural production effectively sold or self-consumed by the family. The totality of production is valorised before self-consumption. Self-consumption of product from the farm for family use is put into the private account (family account separately from the account of the farm) and put on family expenses with the same price (farm gate price). In other words, it is exactly as if the farmer was buying to himself the quantity of product self-consumed.

At the plot level, the gross product per surface unit (acre, hectare or other) therefore corresponds to the yield (minus any post-harvest losses) multiplied by the unit selling price of the products. Rubber trees produce almost all year round (except during the leaf fall period when some farmers stop tapping or during the very heavy rainy season when tapping is difficult). However, the yield of rubber plantations varies along the year with seasons. Data collection should take this specificity and for each season, the following data should be collected to assess the rubber yield: tapping months per season; tapping days per month; production per day per area. The estimated annual rubber yield is calculating on an average annual basis taking into account the yield per season. The seasons can be identified with key informants prior to survey with the farmers or it can be identified with the farmers during the survey.
Gross product (kyat/ac or kyat/ha) = yield (kg/ac or kg/ha) × selling price (kyat/kg)

For livestock systems, the value of production is calculated by adding up, depending on the type of animal husbandry, the litres of milk and/or the kilos of meat produced per animal per year and multiplying by the average unit selling price of each product.
Gross product (kyat/l or kyat/kg) = yield (l/year or kg/year) × selling price (kyat/l or kyat/kg)

At the farm level, the gross product, which is the sum of the gross products of the various cropping and livestock systems, is equivalent to ‘turnover’ as used in general economics.

<u>Calculation conventions</u>
The price taken into account is the ‘farm gate’ price, also called ‘field price’. This is the actual price obtained by the producer for his products when he sells them at his farm.
If the entire production is sold at a market or elsewhere outside the farm (which is frequently the case for rubber), then we take the actual sale price at the market from which we deduct the marketing (transport, etc.) and labour costs necessary for this marketing.
When the sale takes place in several stages, which is generally the case for rubber, a weighted average price is calculated which corresponds to the sum of the various sales (quantity sold ×

price at which sold) divided by the total quantity sold. There is as well a specific item in Olympe to manage that.
In all cases, the gross product is calculated excluding self-consumption, on the basis of the quantity produced.

In Olympe...
The gross product is shown as 'product' in the general farm accounts (GFA) section.
The self-consumed products are bought back by the producer at the same price as that of the sale and included in 'family expenses' in a 'self-consumed products' category that has to be created. The weighted average price is used for these calculations.
By convention, we do not enter the cost of sharecropping in Olympe, never known in advance (since it depends on production), but we enter as gross product only that part of the production that the owner actually receives (most often between 50% and 70% in rubber cultivation).
It is therefore recommended to name the cropping system under study with the suffix 'shcrop' to indicate that the latter is in sharecropping with a sharecropper, and with the suffix 'prop shcrop' for the owner who is part of sharecropping contract as owner .
The output of sharecropping is, in the latter case, indicated in miscellaneous farm income (it is not included in a specific cropping system).
In contrast, farm or land rental is an operational cost like other such costs.

Gross margin and operational cost
The gross margin is equal to the gross product minus operational cost (also called operating expenses, intermediate consumption or variable costs), to which subsidies, if any, are added.

Operational cost, which correspond to expenses incurred in the act of production, processing and marketing, include in particular:
For agricultural production:
* expenses for seeds, fertilizers, phytosanitary products (herbicides, insecticides, etc.),
* motorized equipment costs (petrol, oil),
* water costs in the case of irrigated areas,
* the cost of renting the land,
* veterinary costs, feed expenses and purchase of animals (for livestock systems),
* all temporary salary costs (external labour) allocated to cultivation (temporary hired labour), etc.

For processing: all variable costs of material and labour for processing activities
For marketing:
* all marketing costs (transportation, loading-unloading etc…) if products are effectively sold and marketed directly by the farmers on the market.
* if not: there is no marketing cost: the farm gate price is taken and not the market price.

For rubber, operational cost includes cost of fertilizer, equipment and labour for tapping and maintaining among others.

The gross margin is calculated at the level of each cropping and livestock system, i.e. for each technical itinerary of production (plant or animal).
Gross margin (kyat/ac or kyat/ha) = Gross product (kyat/ac or kyat/ha) – Operational cost (kyat/ac or kyat/ha)

The farm's gross margin is equal to the sum of the gross margins of its different agricultural systems.

Calculation conventions
* Similar to the selling price of products, we can calculate a weighted average purchase price of inputs.
* Costs of using motorized equipment, such as a tiller or a tractor, have to be expressed in terms of working hours and it must be possible to allocate them to particular crops.
* The cost of water is an operational cost, irrigation scheme taxes are generally accounted for as structural expenses (such as property tax, etc.) but cost as well might be integrated into operational costs as it is directly linked with one particular cropping system (irrigation rice). If there is only one plot: the best is to integrate it into operational cost. If there is several plot with different yields and therefore different cropping patterns, then the best is to put it in fixed expenses.
* We include in operational cost farm rental costs (when they are attributable to the plot as a production cost), but not the costs of sharecropping which are directly subtracted at the outset in the calculation of the gross p.
* Only temporary hired labour (without differentiating between task-work and contracted work) is taken into account in the calculation of the gross margin. Permanent employees are included in fixed expenses (also called fixed cost). Family labour is not remunerated (it is assessed in the family labour valorisation).
* Mutual assistance (for labour), which corresponds to an exchange of family labour between farms at different times, is ignored in the calculations, since the labour received corresponds to the labour provided.

In Olympe...
The use of external hired labour is an operational cost like any other and is therefore considered an operational cost.
Family labour is calculated in working hours and not by the day as usual. In contrast, one can use the working day for hired daily workers (considered as a cost) when calculating the costs.
In Olympe, plot-level subsidies are considered as operational costs with zero cost, which leads to the following calculation: gross margin = gross product - (operational cost - subsidies). Farm-level subsidies are considered miscellaneous income at the farm level.
Operational costs are denoted as supplies in Olympe. The gross margin is denoted as margin. At the cropping system level, this is a gross margin/ha. The farm's gross margin (before depreciation and finance costs) is obtained in the major income/expenditure table and is also denoted as margin.
When modelling under Olympe, several categories of operational costs must be created:
* for fertilizers, seeds, phytosanitary products, veterinary costs and animal feed, a unit and a per-unit price are allocated to each expense on the basis of the price obtained from surveys, adjusted to take into account information obtained through additional surveys of merchants;

* for the licence fees, purchase of animals, temporary employees, task-work and rental costs, the expenses are defined in thousands of kyats and the real cost of the expense is entered at the cropping or livestock system level.

Gross value added (GVA)

The gross value added is equal to the gross margin minus the plot- or animal-level subsidies, (gross margin corresponds to the gross product minus the operational costs).
As the name suggests, gross value added is real farm income, i.e. the creation of real value from agriculture and labour (and therefore does not include subsidies).
Subsidies can be either governmental or private.

For cropping systems, the GVA is calculated per unit area (acre or hectare).
Gross value added (kyat/ac or kyat/ha) = Gross margin (kyat/ac or kyat/ha) - Subsidies (kyat/ac or kyat/ha)

For livestock systems, it is calculated either by zootechnical unit (ZU), i.e. by animal, irrespective of the species, or by tropical livestock unit (TLU) by arbitrarily assuming that 1 TLU = 1 cow = ½ adult bull or ox = 6 pigs = 5 sheep or goats.
At the farm level, the GVA is the sum of the GVAs of the farm's different cropping and livestock systems.

<u>Caution!</u>
The definition adopted here for GVA differs from a definition sometimes encountered, which considers GVA as gross product minus operational costs excluding cost of hired labour, and less depreciation of fixed capital (definition used by AgroParisTech and not in line with standards normally used in business management).

Net margin

The net margin (also called net agricultural income) is equal to the gross margin minus fixed expenses (including taxes), finance costs and other costs.

Reminder:
* Structural expenses are fixed costs which do not vary with the level of activity and are not attributable directly to the act of production. They include the costs of renting buildings, maintaining equipment and employing permanent staff, etc;
* The repayment of a loan is equal to the capital borrowed plus the finance costs (value of the costs of servicing the loans).

Net margin (kyat/ac or kyat/ha) = Gross margin - structural expenses - finance costs

This net margin is usually calculated at the farm level. However, it can be calculated at the cropping or livestock system level by allocating the structural expenses to the cropping or livestock system concerned in proportion to their use.
In all cases, it does not include off-farm income.
At the farm level, the net margin therefore represents the household's net agricultural income, before household expenses.

Calculation conventions

All taxes, such as income tax, animal tax or other specific types of tax, are considered structural expenses.

In Olympe...

The net margin which is the result of the general farm account (GFA) section is displayed as 'Result' in Olympe (translated from French "result from General Farm Account) equal to the sum of all net margin for all agricultural activities of the farm.

Depreciation is generally not calculated at smallholder level, as most farmers in the tropics do not integrate depreciation in their strategy. If the farmer is still paying off the equipment in the year concerned, the amount will be included as a finance cost. Otherwise, this equipment is no longer costing him anything; it does not figure in the economic calculations.

It is possible to take into account depreciation and amortization if necessary, but if not, calculation is made upon the concept of "real budget" as perceived by farmers themselves.

For tropical family farming (to adapt to the Burmese case)

In practice, subsidies are rare in the case of family farming. Consequently, the gross value added is almost always equal to the gross margin.

In addition, family farmers rarely pay taxes and there are almost never structural expenses, with the notable exception of farms with permanent staff and/or heavy equipment (tractor or tiller, machinery for producing rubber sheets). The net margin is therefore very often equal to the gross margin minus the finance costs of borrowings. If the farm is self-financed (without any borrowing), then the gross margin is equal to the net margin.

Finally, depreciation is not calculated in tropical family farming, which does not use heavy cultivation equipment, since depreciation is an accounting concept that is not pertinent in a real budgetary rationale.

Depreciation and amortization is interesting for big farms and estates in particular if they pay income tax.

Net value added (NVA)

The net value added is equal to the net margin minus subsidies, which is equivalent to the gross margin minus structural expenses (including taxes), finance costs and other costs.

For tropical family farming (to adapt to the Burmese case)

In the absence of subsidies, as is generally the case with tropical family farming, net value added equals net margin.

Off-farm and non-agricultural income

If you can consider the "farm level": the only income is agricultural income therefore, off-farm income are all the incomes generated outside the farm and are not included.

If you work at the "activity system" level meaning that you consider a farm AND a household, then the total income is the sum of net agricultural income (from on farm activities) + off-farm income from household members (income from outside work: agricultural worker on another farm or non-agricultural income such as civil servant, transport, trade, etc.).

In that case, the family account is different from the farm account.

A household is a group of people who live together in the same dwelling. Often, and it is the case in Myanmar, there is no clear distinction between a family and a household. The members of a household are often the members of a family.
Olympe is scheduled to work at "activity system level" but we can also use only the "farm level": in that case: the family account is not used and the basic table is the General farm account only.

In Olympe...
In Olympe, non-agricultural income is entered into the private family account as family income. We create an 'off-farm income' indicator that aggregates all of this external income.
We thus separate the net margin (denoted result) from non-agricultural income (denoted off-farm income).
To account for the family labour time used for off-farm income, we can create a dummy and masked off-farm annual crop (equivalent sue "catch crop") with only labour times indicated as a trick to wee off farm labour in the same graph as agricultural labour. This allows time used for off-farm work to be displayed with time used for the agricultural activity. Such a workaround does not, of course, change the economic calculations, but allows one to see the total use of on-farm and off-farm family labour.

For tropical family farming (to adapt to the Burmese case)
In general, there are many transfers between agricultural income and non-agricultural/off farm income, in particular in the form of cash flows.

Total net income (TNI)
The total net income calculated for a farm is equal to the sum of the net margin and non-agricultural/off-farm income.

Cash balance
The cash balance, which is calculated at the farm level, is equal to the total net income minus all consumption and family expenses (including self-consumption).
The cash balance is the capital remaining in the farmer's hands at the end of the year, after all expenses have been paid for (for the farm as well as for the household).
We can consider the cash balance to be the theoretical investment capacity.
In reality, the investment capacity is always lower than the cash balance because farmers prefer an immediate improvement of their living standards over future investments, more so if they are poor.
The real investment capacity is therefore obtained by deducting from the cash balance all non-productive expenditure for improving living conditions.

Calculation conventions
Self-consumed products are considered to be "family expenses", accounted for with the weighted average price used for the valuation of production. This accounting method makes it possible to obtain a real cash balance.

In Olympe...

To obtain a farmer's real investment capacity, household consumption (at least the domestic use of net income) has to be estimated. This can be done through surveys and on the basis of the characterization of the farm.

Return to labour

Return to labour, a metric of labour productivity, is equal to production divided by the number of working days it took to obtain that production.

Return to labour, expressed in kg of product per working day, makes it possible to compare the productivity of different systems for the same product (for example, rubber plantations with different tapping systems) and to compare systems over several years irrespective of price changes. However, return to labour cannot be used to compare systems whose productions are different (rubber trees with oil palm, for example). It can be used to measure the real effect of using a new technique and therefore of an innovation process, without price changes invalidating or distorting the comparison.

Return to labour (kg/day) = Yield (kg/ac or kg/ha)/Working time (days/ac or days/ha)

To compare labour productivity of different crops, we use the daily "labour valorisation", or net margin per day of family labour.

Labour valorisation (kyat/day) = Margin (kyat/ac or kyat/ha)/Working time (days/ac or days/ha)

In English, both concept are used with the same expression "return to labour" as in French the two concepts (similar but different) have a different name.

Calculation conventions

Return to labour is expressed only in kg of product per day (or hour) of labour.

It can be calculated at the plot level by dividing the total production of the plot (in kg) by the number of working days on the plot concerned. Return to labour can also be calculated per unit of surface area (acre or hectare), by dividing the yield (in kg/ac or kg/ha) by the number of working days per acre or hectare.

In Olympe...

Family work is recorded in hours to adapt to European standards where mechanization time is reported in "hours" and not "mandays".

To obtain return to labour in kg/day, we have to multiply the return to labour in kg/h by the average duration in hours of a working day in the area.

Caution!

Since return to labour is by definition the productivity of family labour, it makes it possible to assess systems in a diversity of farms on the basis of real situations.

However, the ratio of family labour to hired labour varies widely from farm to farm, which leads to a distortion when we want to compare the economic performance in absolute terms of different technical itineraries or cropping systems.

Consequently, to undertake such a comparison, it is necessary to consider all labour (family and hired) as being provided by the family (we thus calculate a 100% family return to labour).

In this case, hired labour is taken to be nil and the calculated gross margin amounts to a gross margin excluding the cost of hired labour.

Labour valorisation (LV) or daily labour valorisation

The gross labour valorisation is equal to the gross margin divided by the family labour time. It is another way of expressing the concept of labour productivity.

In a similar way, the net labour valorisation is equal to the net margin divided by the family labour time.

In general, the gross labour valorisation is used to assess or compare cropping or livestock systems whereas the net labour valorisation is used at the farm level. It indicates the economic efficiency of production systems.

This definition makes it possible to measure values representative of the real family labour valorisation. However, since the LV is dependent on the sale price of the productions, it cannot be used to compare systems across years when the prices fluctuate (which is usually the case).

Labour valorisation is expressed in the currency used, for example in kyat/day (or kyat/hour) in Myanmar.

<u>In Olympe...</u>

We calculate family labour valorisation at the level of the cropping and livestock systems by dividing a cropping or livestock system's gross margin by the number of hours worked at this cropping or livestock system.

This calculation is found in the margin option, denoted margin/hour.

We also calculate the family labour valorisation per day (or hour) at the farm level over a year by dividing the net margin (denoted result) by family labour time (calculated as the number of working family members multiplied by the number of working days per year, which is 250 on average).

Opportunity cost

Opportunity cost is the measure of the benefits that are forfeited by allocating the available resources (in our case, labour) to a given purpose outside the farm. It corresponds to the amount that it is possible to earn for a day of salaried work outside of the farm. This work is generally temporary in nature.

There are several local opportunity costs, which too can vary over time. It is therefore necessary to specify this opportunity cost precisely, such as for example:

* basic agricultural worker daily salary at 4000-5000 kyat/day in 2019 (it may vary based on task, labour availability in region and season);
* employee in a rubber processing plant at 7000-10000 kyat/day in 2019 (it may vary based on the labor availabilities);
* city worker at 5000-10000 kyat/day in 2019 (it may vary based on the job type and labour availability) .

<u>Caution!</u>

Since, by definition, the calculation of labour valorisation relies on family labour time, it can be used to assess the performance of farm systems on the basis of real situations.

As with return to labour, if we want to compare different cropping systems with each other, it is necessary to consider all labour (family and hired) as family labour in the calculation. We

thus calculate a labour valorisation as being contributed 100% by the family, which makes it possible to compare systems – assuming all other factors are equal.
It requires having good quality and detailed information on family labour real use. “Family labour” = “livelihood labour” or “housework”

Intensification ratio and return on investment
The intensification ratio is equal to operational cost divided by the gross margin.
The return on investment is equal to the net margin divided by operational cost.
These two ratios, expressed as percentages (%), are indicators of the intensification level of farming systems and of the benefits and risks of running particular cropping or livestock systems and of intensifying them.

Operating ratio
The operating ratio is calculated as the total operational cost for one unit of product x 100 divided by the current farm gate price (or market price if there is some marketing expenses). A ratio lower than 100% indicates an operating surplus. Opposite, a ratio above 100% indicates an operating deficit. In other words, the smaller the operating ratio, the greater the margin and the higher level of competitiveness.

The self-consumption ratio and the ratio of satisfaction of needs by production
The self-consumption ratio for a given product (such as rice) is equal to the quantity of this product self-consumed by the family divided by total production on the farm.
The ratio of satisfaction of needs by production is the inverse (reciprocal) of the self-consumption ratio. It is equal to farm production of a given product divided by the household consumption of this product.

2. Using economic indicators

These economic indicators can be used for two different purposes:
* assessment and comparison of real farm income (which can be undertaken for each individual farming system as well as at the overall farm level);
* the assessment of the economic performances of different cropping or livestock systems as well as comparisons between these systems.

Some indicators can be used for both purposes, while others fulfil different functions and are specific to only one or the other. It is important to distinguish between two main types of calculations:
* to measure the real economic performance of a farm (or of a cropping or livestock system within a particular farm), all the calculations are made by taking into account the real costs, by including non-family labour expenses as a cost, by taking into account the real finance costs of this farm or those pertaining to the cropping or livestock system under study, and by taking into account subsidies, if any;
* to compare the performance of cropping (or livestock) systems and of technical itineraries, it is necessary to remove from the calculation the factors that differ from one farm to another in order to compare the systems under conditions of all other things being equal. To this end, we consider that all labour is family labour, that all of the activities are self-funded (therefore

without finance costs) and that there are no subsidies, taxes or structural expenses (except when comparing technical itineraries with or without mechanization).

2.1 Assessment of the economic performance of farms

Measured or calculated values

To be able to assess the real economic performance of farms, we have to measure or calculate several indicators for each type of farm.

For each crop (or crop association):

- the yield (kg/ac or kg/ha);
- gross margin (kyat/ac or kyat/ha);
- gross value added (kyat/ac or kyat/ha), often equal to the gross margin;
- return to labour (kg/day or kg/hour);
- gross family labour valorisation (kyat/day or kyat/hour).

At the level of each cropping system, the economic data are calculated by aggregating the economic values for each crop and dividing the result by the number of years in the rotation. This calculation takes into account the investments made in one crop and having effects on other crops. We calculate as follows:

- gross margin (kyat/ac/year or kyat/ha/year);
- gross value added (kyat/ac/year or kyat/ha/year), often equal to the gross margin;
- return to labour (kg/day or kg/hour);
- gross family labour valorisation (kyat/day or kyat/hour);
- intensification ratio (%);
- return on investment (%).

At the plot level, we can also calculate the net family labour valorisation (by allocating the structural expenses in proportion to the cultivated areas), except in the (rare) case where all of the labour is hired. In this specific case, we are in a situation of a family-managed farm, which Belières *et al.* (2015)[3] call 'family business holding'.
All of these measurements or calculations are done for each type of production.

For each livestock system, we can additionally calculate:

- gross value added/zootechnical unit/year;
- gross family labour valorisation (kyat/day or kyat/hour).

At the farm level, by adding the different cropping and livestock systems, we can calculate:

- the farm's gross margin, which corresponds to the sum of the gross margins of the farm's cropping and livestock systems (kyat/year);
- the farm's net margin, which corresponds to the sum of the net margins of the farm's cropping and livestock systems (kyat/year) and also to the sum of the gross margins minus all the structural expenses (always calculated before self-consumption);
- the total net income (kyat/year), which makes it possible to calculate
- the cash balance (kyat/year).

[3] Bélières, J. F., Bonnal, P., Bosc, P. M., Losch, B., Marzin, J., & Sourisseau, J. M. (2015). Family farming around the world. Definitions, contributions and public policies. AFD, Cirad, Paris. Collection *À savoir*, no. 28.

All of these values make it possible to assess a farm's financial state and compare its results with those of other farms.

We can then calculate the ratios of these values per worker:

- the farm's net margin divided by the number of workers (kyat/worker/year);
- total net income per worker (kyat/worker/year);
- the cash balance per worker (kyat/worker/year).

We can also calculate:

• the self-consumption ratio for a given product (such as rice in particular or any other crop that is the staple for the families in the region) or the ratio of satisfaction of needs by production.

• the theoretical consumption of paddy rice per year for the family considered. This makes it possible to check the consistency of the data with regard to the quantities of rice self-consumed or purchased, as declared by the producer.

At the farm level, we can also calculate the following ratios:

• coverage of operational costs by borrowings, which is equal to the capital borrowed (excluding finance costs) divided by operational costs;

• debt ratio which corresponds to the total amount of repayments in the year divided by the farm's net margin.

Finally, when possible, we can calculate the accumulated cash balance over a period of ten years.

<u>Calculation conventions used</u>

By convention, we assume:

- man older than 15 years = 1 MWU (man work unit);
- woman older than 15 years = 0.8 MWU;
- child younger than 15 years, not going to school and working on the farm = 0.5 MWU;
- grandparents older than 60 years working on the farm = 0.5 MWU.

For the mouths to feed, we assume:

- adult man or woman older than 15 years = 1;
- child younger than 15 years = 0.5.
- grandparents older than 60 years working or not on the farm = 0.5 (members of the household)

Average rice consumption is 160 kg/year of white rice for one adult, man or woman, or roughly 300 kg of paddy rice per adult per year. For children younger than 15 years old or grandparents older than 60 years old, the average rice consumption is 80 kg of white rice and 150 kg of paddy rice per person (child or grandparent) and per year (50 % of an adult).

<u>In Olympe…</u>

We create a family labour category in MWU (man work unit) which allows us to enter the number of workers per farm and thus calculate the different types of income per worker.

We also create a category for number of dependents with a variable for number of people actually dependent on the household.

Special case for large farms

The case of large farm owners, estates or family business holdings, requires a different calculation since:

* the workforce is mainly, if not entirely, hired;
* the farm can be considered a business in which all the factors of production are remunerated or have to be paid for, except the land;
* the capital is generally sufficient to allow a certain level of intensification.

We can then do the economic calculations by assuming that the entirety of the work is done by hired labour, at the rate usually prevalent for each task in the area under study and during the actual periods concerned. If we know the exact distribution of labour time to different cropping and livestock systems, we can assign the cost of labour to them. The net margin per unit of area (acre or hectare) will then include the share of structural expenses divided according to the surface area. If we do not know this distribution, then all the labour costs are allocated to the structural expenses. In this case, the margins obtained for a cropping or livestock system then exclude the labour cost. Another solution is to allocate salaries of permanent staff to structural expenses and only the cost of temporary staff to operational costs.

In all cases, we do not calculate the family labour valorisation since it does not make sense (family labour being zero), but we can calculate the total labour valorisation (margin divided by total working time) and compare it to the cost actually paid for the work concerned.

Interpretation of farm-level results

The **gross margin** and the **net margin** of the farms are calculated excluding self-consumption. They therefore indicate the agricultural income before self-consumption, which makes it possible to compare one farm with another.

Special case of large farms using both family and hired labour

In the case of family business holdings relying only partly on family labour, we can compare two types of calculations:

* the first by considering that all of the work has been done by hired labour at the rate usually prevalent for each task during the actual periods concerned in the area under study;
* the second by considering that all of the work has been done by family labour.

The comparison with the family labour reveals whether the use of outside labour is economically beneficial or not. In the case where external hired labour is very inexpensive, it is always beneficial to take recourse to it.

The **net margin** indicates production activity at the farm level more accurately than the gross margin. The net margin is therefore used to measure the efficiency of farms and compare them with each other, especially when the farms being compared have very different fixed costs and finance costs.

The **cash balance** indicates the capital actually available at the end of the year, after all the farm and household expenses have been made, by aggregating all of the family's income, including non-agricultural income.

The cash balance therefore reflects the money that actually remains with the family at the end of the year and therefore makes it possible to measure the farmers' very real cash flow problems. This balance can be positive, negative or nil. We can then deduce whether the

family has become richer (it is thus able to capitalize), has become poorer, or has maintained its economic level during the year. It also gives an idea of the farm's ability to generate an income once its family needs are covered by self-consumption and therefore of the potential self-financing capacity.
If the cash balance is positive, the farmer can choose to save, invest (in a motorized tiller, for example), pay for his daughter's wedding, etc.
The calculation of cash balance requires having a good quality and accurate level of family expenses (with adapted consumer survey, even if not very detailed but should be accurate). Theoretically, cash balance cannot be negative or only exceptionally.

Calculated over ten years, the **cumulative cash balance** shows whether the farm is in a capitalization phase, (relative) stabilization phase or decapitalization phase.
The farm's net margin, cash balance and cumulative cash balance are very useful and practical indicators to obtain an overview of the farm's development, or for comparisons between farms.
Gross value added, which corresponds to the creation of wealth through agricultural activity, is very often equal to the gross margin since subsidies are rare.
Return to labour (production divided by working time) and **labour valorisation** (margin divided by working time) are two very useful indicators, but for different uses:
* return to labour allows systems to be compared from one year to the next, irrespective of changes in prices, but it does not allow systems with different products to be compared, and cannot be calculated for crop associations;
* labour valorisation allows the comparison between systems of all types, for a given year, but it cannot be used to compare systems from one year to another because it incorporates prices, which are very volatile and vary from one place to another. An interesting option can be to express monetary values in kilo equivalent of paddy rice for example. Paddy is the most consumed and important staple food for the Burmese peasantry, and this weighting by rice leads to more robust results which make it possible to overcome interannual price variations.

A farm's various cropping and livestock systems can thus be compared and the choice of cropping or livestock systems optimized on the basis of:
* the margins generated (per unit area or per animal), which makes it possible to optimize the available land or animal resource, and/or
* the family labour valorisation, which makes it possible to optimize family labour resources.
It is also useful to compare the labour valorisation of the various cropping and livestock systems with the **opportunity cost** at a given time and in a given place (because this opportunity cost varies widely). It is therefore necessary to determine this opportunity cost and identify the different opportunities, by area and by season. A labour valorisation that is below the opportunity cost indicates that the cropping and livestock system under study may not be worth continuing with.

Similarly, at the farm level, the calculations of the farm's **net margin per worker**, the **total net income per worker** and the **cash balance per worker** allow a comparison with non-agricultural activities. If the total net income per worker is less than an annual salary that can be obtained outside the farm, agricultural activity may not be worth continuing with.

The **intensification ratio** (operational costs divided by gross margin) can be used to assess the risk taken to continue with a cropping or livestock system. A ratio higher than 50% is considered excessive and potentially dangerous.
The **return on investment** (net margin divided by operational costs) provides information on the potential benefit of taking a risk of continuing with a system. If it is, for example, less than 50%, one can question whether such a significant risk (if the intensification ratio is high) should be taken for such a poor economic result. A return on investment greater than 200%, on the other hand, indicates a definite benefit in taking the risk of intensifying the crop concerned (provided that the farmer is able to manage the consequences in case of failure).
The **self-consumption ratio** indicates to what extent a farm is monetarized. A farm is considered to be monetarized when its self-consumption ratio is less than 50%.
The **ratio of satisfaction of needs** by production indicates to what extent a farm is self-sufficient. This metric is used for farms focused on direct food self-sufficiency (in particular in rice), which is often an important criterion for differentiation for farm typologies in some countries. It is little used for farms focused on export crops
We can look at the relative shares of household agricultural and non-agricultural incomes and possibly see transfers from one income to the other.
The **coverage ratio of operational costs by borrowings** is used to assess the borrowing risk. At the farm level, a ratio greater than 2/3 constitutes significant risk taking (inability to repay in the event of a production accident) and lowers the net margin due to the significant finance costs.
Finally, an important indicator is the **debt ratio**. If it is too high, the farm's debt is too elevated and difficult to repay and service. In general, this ratio must be kept below 30%.
These economic indicators therefore make it possible to measure and assess, in a real situation, the cropping or livestock systems' economic efficiency (gross margin and labour valorisation) by activity or at the farm level, and to correctly explain the peasant strategies that incorporate other factors, especially cash balance and risk.

2.2 Assessment and comparison of different systems

On the other hand, the assessment and comparison of the economic performance of technical systems (in particular cropping systems) requires that these comparisons be made under conditions of 'all other things being equal'. Comparisons between systems are essential for their development and for the dissemination of the best amongst them.

In order to avoid distortions in comparisons of systems in small family farming that may result from differences between farms, by convention we compare systems and technical itineraries by assuming:
• that all of the work is carried out by family labour;
• that there is no depreciation of equipment;
• that sales and purchases are done entirely through cash transactions, without credit;
• that farmers use their land without rental costs, usage fees and taxes (with the exception of water costs in irrigated systems, which can be considered input costs);
• that seeds are self-produced and obtained from the previous harvest;
• that all of the production is sold at harvest time (and therefore at the average harvest price, thus avoiding distortions in the comparison due to seasonal price variations), while taking into

account that some systems may be designed to arrive at production at a time when prices are attractive.

In a similar way, to avoid distortions in comparisons due to the type of environment in which a system exists, the comparison must be made on the basis of an agronomic unit (these units can be defined for each major agroecological zone).
We can thus identify the most efficient systems for each agronomic unit. By studying the different agronomic units, we can also identify:
* systems that behave well – and those that do not – in a large number of situations;
* systems that are very efficient in certain situations but inefficient in others which are less favourable to them; and even
* systems that do not perform very well in absolute terms, but which are particularly well suited to very difficult situations, which allow, for example, for the derivation of some value in disadvantaged areas.

For perennial crops such as rubber, which have a relatively long immature period before they start producing, it is necessary to perform calculations by age classes.

Finally, since the results will perforce be variable, it is necessary to conduct comparisons between cropping systems using averages from different plots (minimum 5), of the same age, belonging to the same agronomic unit, on which the same cropping system/technical itinerary has been practised. It may be worthwhile to calculate the standard deviation. If it is high, the performance of the system concerned exhibits high variability. In this case, we can, for information purposes, calculate the system's performance on the worst and best plots.

It is therefore useful to calculate the following indicators to assess a farm's economic activity:
* gross product or turnover which gives a general idea of the amount of sales but not of income;
* operational cost, more or less significant and which indicate the level of resilience concerning the use of inputs and the volatility of their prices;
* the system's gross margin with 100% family labour (kyat/ac or kyat/ha), which is also equal to the gross value added (since subsidies are considered to be nil) as well as to the net margin (since the structural expenses and finance costs are considered to be nil);
* 100% family return to labour (kg/day or kg/hour);
* labour valorisation with 100% family labour (kyat/day or kyat/hour);
* return on investment with 100% family labour, without recourse to credit (in %);
* the system's intensification ratio with 100% family labour (in %).

<u>Calculation conventions</u>
To calculate average production per unit area (acre or hectare), we must calculate the average yield for plots of the same age class, having followed the same technical itinerary. We propose not using weighted yields by area, but to instead average the yields of each plot of the system under consideration (a more realistic value of the system's average production, which prevents large plots from having a greater weightage than small ones).

Calculation conventions

To perform these calculations with the assumption that the family provides 100% of the labour, it is necessary to replace the hired labour in equivalent family man-days. This poses certain difficulties:

• we cannot use the cost of the hired labour since this cost will vary depending on the period and the types of tasks, and between different regions (depending on the relative availability of labour).

• the duration of a 'working day' varies depending on the task (for example, a 4-hour ploughing day, but 6 to 8 hours for weeding and hoeing depending on the region);

• the case of contract work requires special treatment.

To obtain the most accurate results possible, we suggest;

• systematically specifying the period and the price of labour for each task;

• systematically specifying the duration in hours of a 'working day' for each task;

• recording labour in hours, and converting the results into working days of 7 hours on average to standardize considering that for some tasks, especially for rubber activities, working hours may be different in different countries;

• for contract work, recording the number of working hours for the task and calculating an hourly cost corresponding to the cost of the task divided by the time taken to do it. This calculation has the advantage not only of including an approximation of the equipment's depreciation, which is included in the price of the contract work, but also of recording the hours of work required for the task concerned.

However, it is time-consuming and complicated to take these measurements, and it is impractical to do so on a large number of farms.

Based on surveys and precise measurements of this data, it is however possible to determine local standard work times, which can then be used for these calculations.

Calculation conventions

To be able to compare systems with each other, it is necessary to determine reference prices for the different products and inputs. Determining unit prices is often made difficult by large fluctuations over time, differences between areas (sometimes over very short distances) and by variations in the very definition of units (often in local, variable units).

As these unit prices can very strongly influence the net margin (in particular the product selling prices) and labour valorisations, it is essential that we take the most realistic values possible for the calculations.

For the product selling prices, we recommend taking the average selling prices prevailing in the nearest purchasing area at harvest time. Even though the entirety of the production is not always sold at that time (all the more so if a part of the production is retained for self-consumption or to be sold when prices are more favourable), it is often during this period that most of the harvest is sold, in particular to repay loans taken for the season and to pay labour for the harvest.

This price is often the lowest of the year (prices drop when a large supply hits the market), which avoids an overestimation of the economic performance of the systems under study. This approach also makes it possible to highlight the advantage of systems which allow an early harvest, during the lean season, and therefore at a period of high product selling prices. For this reason, it is important to distinguish clearly the product selling prices by system, depending on when the production reaches the markets.

It is also worthwhile to monitor product price fluctuations on local markets because we can then simulate the gains achievable by early production or, on the contrary, by product storage. For input prices, we simply take the price on the local market.
This method of calculation has the advantage of making it possible to harmonize prices between different regions, and thus to compare the performance of systems in different regions.
For short-cycle crops, seeds are assumed to have been obtained from the previous harvest and valued at the product selling price with a premium of 20% for purification and partial renewal with selected seeds.
In all cases, the unit prices used and the method of obtaining them must be clearly laid out.

The **margin** makes it possible to compare the economic performances of systems (how much they earn) and to identify the systems which derive the highest value from the land.
The **return to labour** and **labour valorisation** make it possible to identify the systems that derive highest value from the labour force.
Operational costs represent the amount of investment to be made in the system, which is very often a limiting factor for small farms.
The **return on investment** makes it possible to identify the systems that derive best value from the capital invested, while the **intensification ratio** makes it possible to quantify the risk taken in continuing with these systems.

3. Modelling and assessing systems in Olympe

Olympe is a tool for assessing the economic performance of systems at several levels: i) at the plot, technical itinerary or cropping system levels, ii) at the farm level (concept of GFA or general farm accounts), and iii) at the level of a group of farms (with the 'set' module in Olympe). This analysis can be carried out on an annual basis, over a specified period of time or even over several 10-year periods in 'current currency', i.e., at the value observed during the survey period. There is no updating (constant currency) module in Olympe but this can be done through Excel exports.

Olympe allows a farm to be compared with or without a technical change, before and after the change, and can therefore be useful in decision-making for producers. As a prospective tool, Olympe can simulate possible or probable change scenarios and can be used to compare various situations between them. In addition, it can be used to construct resilience indicators and undertake a risk analysis.

Finally, Olympe can be used to follow, over several years, farms belonging to a network of reference farms in a given region.

Cropping and livestock systems in Olympe are broadly equivalent to the technical itineraries/pathway of the various cropping or livestock systems (which can be grouped into categories). Cropping and livestock systems are called activities in English (atelier in French)
In Olympe, the cropping systems are not systematically linked to plots. A user can manage specific plots by considering a technical itinerary linked by definition to a plot of his choice.
You can also incorporate several crops grown in association into a single cropping system or include them as successive crops (with the correct button called "trueFalse" crop').

True crop means the first crop.
False crop is the second annual crop on the same plot. This system avoid to calculate twice the cropped area for the second annual crop (very common generally in irrigated scheme … but also with short long span crops)
We can therefore link each cropping system to a plot or decide not to do so (which does not change the economic analysis in itself).

For medium- and long-term cropping systems, i.e. those with cycles ranging from 10 to 50 years, such as coffee, cocoa, rubber and oil palm, one can normally use the 'perennial' module. To do so, one has to know all the data by period (with periods corresponding to the different phases of the plant cycle) from the start to the end of the complete crop cycle.
If these data are not available, you have to choose between two techniques to characterize your cropping systems in Olympe:
* by using the 'crop' module (by definition generally used for annual crops) to qualify 'standard production years', usable when the crops are in stable production (on the plateau of production: for example, between 10 and 25 years for rubber). It is then necessary to define a simplified annual technical itinerary;
* using the 'multi-year' module (by definition generally used for multi-year crops such as bananas, pineapples, sugar cane and cassava for 18 months, for example) assuming that the technical itinerary is longer than 1 year but shorter than 5 years. This module is very little used for perennial plants: for example, it can be used for the first 4 years of coffee then we can switch to standard years for the sake of simplification. This module cannot be used for rubber.

After having entered the various incomes and expenses, we obtain the various indicators by activity or at the farm level.
The gross margins by activity can be found in the 'margins' table under 'results' under 'enterprises', after having selected the types of products desired (example: all rubber, all rice, all market gardening, all livestock etc.).
The margin by activity or type of activity at the farm level makes it possible to determine the origin and breakup of agricultural income by type of activity or product. For example, the margin for rubber (all technical itineraries combined) or the margin for rice.
You can export Olympe's tables of margins by cropping/livestock system as spreadsheets (Excel) and obtain a global table of all economic results by cropping/livestock system (technical itineraries).
At the farm level, the margin is displayed in the 'income/expenditure' table or 'major heads income/expenditure (summary)'. The comparison between margins and the comparison of labour valorisation by activity (economic expression of the return to labour) with the opportunity cost helps explain the strategies of allocation of production factors and in particular of the labour factor.
For the calculation of the cash balance, non-agricultural/off-farm income is entered in the 'family' account under 'family income', and an 'off-farm income' indicator is created which aggregates all of this external income. We then create a 'calculated total income' indicator equal to the net margin (called 'result') + these 'off-farm incomes'. Finally, we create a 'real total income' (cash balance) indicator which is equal to 'total calculated income' minus the total value of self-consumed production.

One of the difficulties of undertaking this work is that there is very often a difference between what the farmer declares during the surveys and what he actually practises. Indeed, the farm-level approach, which provides an overview of the activity system over a long time step, is very different from the approach that the peasants use for their farms.
Data from the previous year are sometimes very difficult to obtain, especially since we are dealing with diversified and complex systems, with a high level of integration between the production system and the household (the share of self-consumption can be significant). Furthermore, a great many actors are involved (family labour is often plentiful but is not always available, employment of temporary and/or permanent labour, temporary employment contracts), depending on the farmer's constraints and the opportunities he gets. In addition, the farmers' strategy is not necessarily to optimize their production factors with the aim of maximising their earnings.

To limit the risk of errors, it is necessary to carry out some checks. To this end, in Olympe we create:
* a variable for the number of people to feed on the farm, which aggregates the number of family members as well as the number of permanent employees who are fed;
* a variable for the declared self-consumption to which the quantity in kilograms of rice declared as not sold by the farmer is allocated;
* a calculated self-consumption indicator which corresponds to the variable for the number of people to feed on the farm multiplied by the average paddy consumption in Myanmar;
* an indicator in the form of a ratio of the variable 'declared self-consumption' over the indicator 'calculated self-consumption', called 'declared over calculated self-consumption';
* two indicators 'share of declared self-consumption' and 'share of calculated self-consumption' which correspond respectively to the ratio between the quantity of paddy not sold by the family (as per the farmer's declaration) and the total quantity produced on the farm, and to the ratio between the calculated quantity of self-consumed paddy and the total quantity produced on the farm.
* two indicators 'declared self-consumption over family expenditure' and 'calculated self-consumption over family expenditure' which give us in percentage the share that self-consumption represents in family expenditure.
* two indicators 'declared self-consumption over cash balance' and 'calculated self-consumption over cash balance' which give us in percentage the share that self-consumption represents in the cash balance of the activity system.
We do not take the hulling costs into account when calculating the value of the calculated self-consumed production (for the indicator). As its name suggests, this indicator just allows us to visualize the impact of the overestimation of declared self-consumption on the various economic calculations.

In Olympe, all amounts are expressed in thousands of kyat.
Return to labour and labour valorisation are calculated per hour and per day.
Year 1 corresponds to the current year (the year in which production and harvest takes place). For work carried out in the calendar year prior to the result year, we use 'previous 1', generally for all cropping activities implemented before January of the "harvest year".

To summarize

For the economic evaluation of cropping systems, we consider the following elements:
Gross product (kyat/ac or kyat/ha) = yield (kg/ac or kg/ha) × selling price (kyat/kg)
Operational cost (= operating expenses = intermediate consumption = variable costs), which are absorbed in the act of production, include in particular:

* costs of seeds, fertilizers, phytosanitary products (herbicides, insecticides, etc.);
* motorized equipment costs (petrol, oil);
* the water cost, if any;
* the cost of renting the land;
* veterinary expenses, feed costs and purchase of animals (for livestock systems);
* all temporary salary costs allocated to cropping.

Gross margin (kyat/ac or kyat/ha) = Gross product (kyat/ac or kyat/ha) – Operational cost (kyat/ac or kyat/ha)
Gross value added (kyat/ac or kyat/ha) = Gross margin (kyat/ac or kyat/ha) - Subsidies (kyat/ac or kyat/ha)
Net margin (kyat/ac or kyat/ha) = Gross margin - structural expenses - finance costs
Labour valorisation (kyat/day) = Margin (kyat/ac or kyat/ha)/Working time (days/ac or days/ha)
Return to labour (kg/day) = Yield (kg/ac or kg/ha)/Working time (days/ac or days/ha)
Intensification ratio (%) = Operational costs (kyat/ac or kyat/ha)/Gross margin (kyat/ac or kyat/ha)
Return on investment (%) = Net margin (kyat/ac or kyat/ha)/Operational costs (kyat/ac or kyat/ha)

To be able to compare systems with each other, we assume:

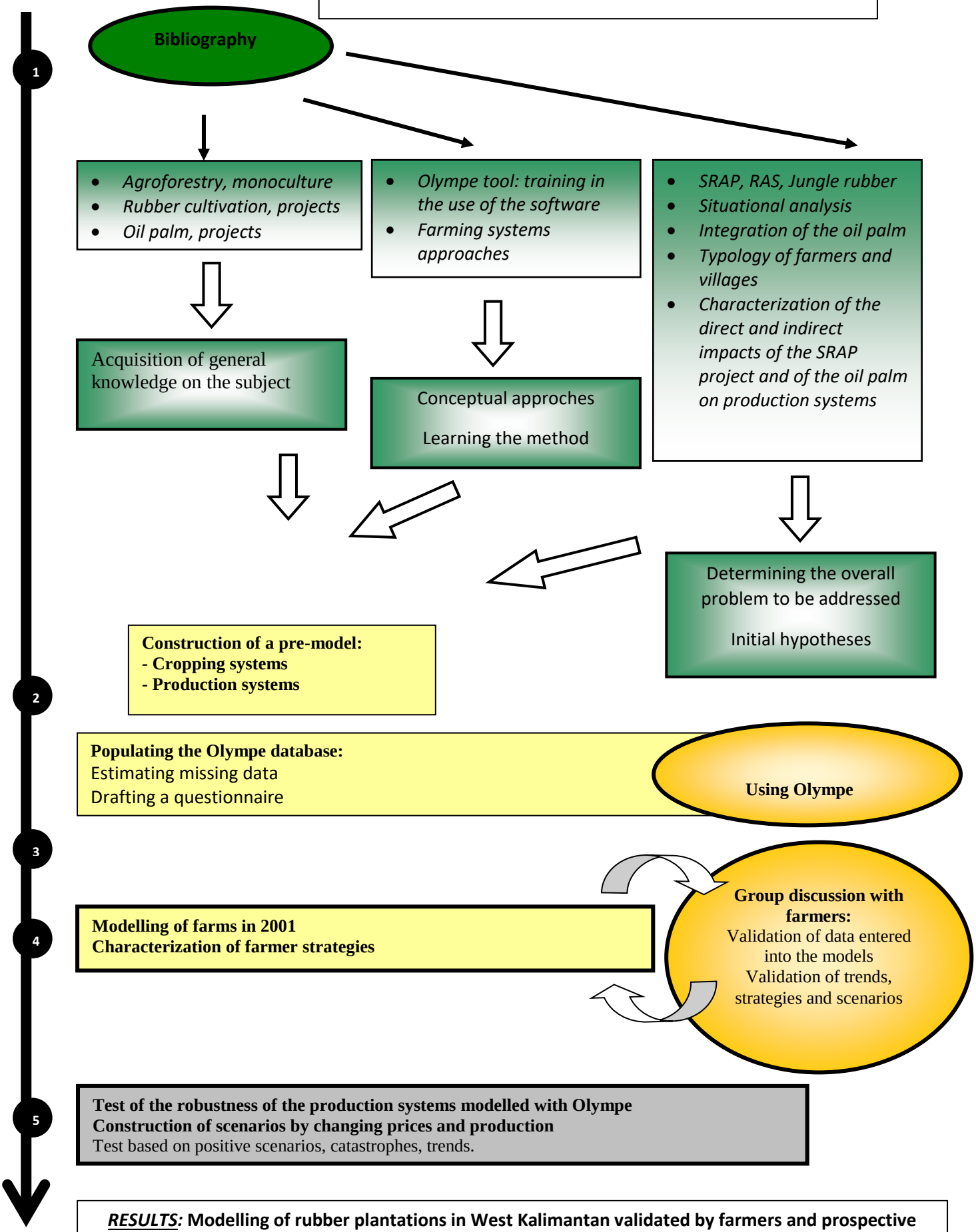
* that all of the work is done with family labour;
* that there are no finance costs (no borrowing for cropping);
* that there are no structural expenses or subsidies, which means that:

Gross margin = Net margin = Gross value added

At a farm level, the sum of the different cropping/livestock systems (divided by the number of years) makes it possible to calculate:

* gross farm output (sum of gross products, in kyat/year);
* the farm's operational costs (sum of operational costs, in kyat/year);
* the farm's gross and net margins (kyat/year);
* the farm's structural charges and finance costs (kyat/year);
* labour valorisation (kyat/day);
* the farm's intensification ratio and the return on investment (%);
* total net farm income (the farm's net margin + non-agricultural income; kyat/year)
* the farm's cash balance (Total net income - household consumption; kyat/year)

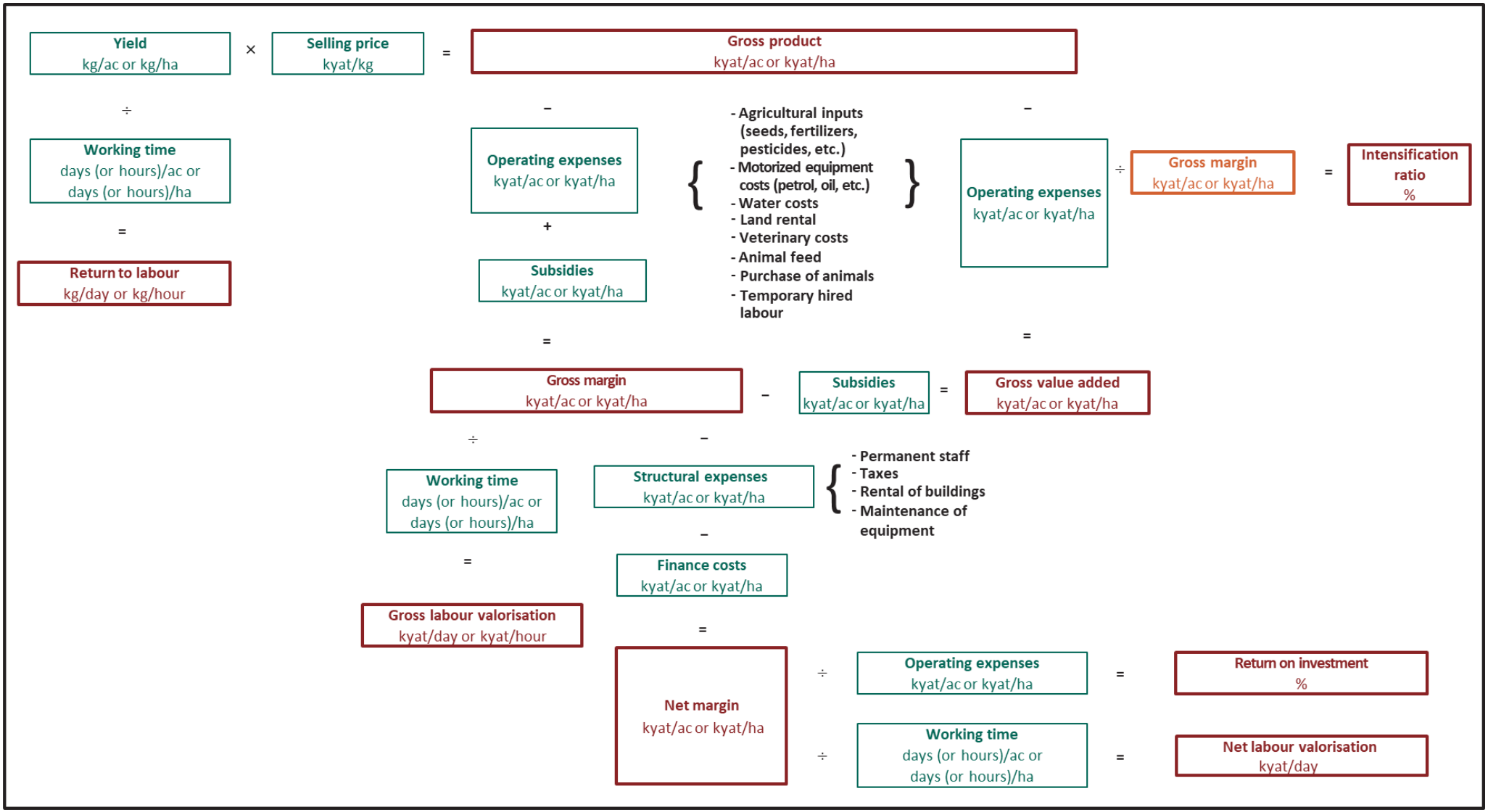
Figure 1: Using Olympe: example of agroforestry systems in Indonesia



RESULTS: **Modelling of rubber plantations in West Kalimantan validated by farmers and prospective analysis of these farms**

Presenting Olympe, an overview

Economic indicators used to assess and compare cropping and livestock systems on farms



Economic indicators used to assess and compare farms