CHAPTER 3

DESCRIPTION OF THE MODEL

This chapter includes simulation modelling and testing the modelling on estimates for ParaSight test.

1. Simulation Modelling

1.1 General Considerations

The model is developed on the basis of study of the malaria control program in Thailand related to diagnosis and treatment policy and on experiences acquired from the testing of new diagnostic techniques.

The model is an instrument for economic analysis of introducing a new malaria diagnostic test able to avoid waiting time of the existing technology being considered as the main cause of inappropriate drug consumption which is thought to be a determinant factor of drug resistance.

Economic analysis includes the costing of inputs and the valuation of outcomes in the cost benefit analysis approach.

Costing of inputs should take into consideration:

* levels of malaria endemicity: size of population at control area and amount of population per service point which can be served by the new test without waiting time determine the number of service points, number of service points by their turn identify establishing costs for the new test. As above mention, number of test performed are influenced by annual malaria incidence. In this study, we are interested in the application of on the spot test for

control area so the annual incidence per 1,000 population at control area must be concerned:

* levels of cost: any test consists of not only the cost for performing at the field but also the cost for administration, supervisor, quality control at upper levels.

* activities of introducing a new malaria diagnostic test: in order to introduce a new technique, the costs compose of cost for establishing (equipment costs, space cost, trained person cost etc.) and cost for running of this technique (maintenance costs, consumable costs etc.).

* types of cost: in order to analyze the structure of costs, we should classify the costs into some types, such as capital cost as cost to be invested once for establishing service points so that the service points are able to conduct the new test; annual fixed cost for running a new test. It's not dependent on the number of tests to be performed; annual variable cost for running a new test dependent on the number of tests to be performed.

* present value of future running costs: capital cost is invested once at the beginning of application of new technique but running cost (fixed cost and variable cost) must be allocated every year. In order to calculate the cost for some years, the present value of future cost should be concerned. It depends on annual interest rate and present cost.

* components of cost: cost system can be also classify into activities including training cost (training for persons who implement the test as well as for persons who conduct quality control for the test), equipment cost (for new test and for its quality control. They may be difference), space cost (for both implementing the new test

and conducting quality control), annual salary cost (for those who conduct the test at field level and for those who conduct quality control test at upper level), maintenance cost (including retraining, maintenance space, maintenance equipment,...), consumable supply cost (it may be kit of test, chemical, etc,...).

Valuation of outcomes should consider

* Time frame: The benefit may be difference within time frame. The calculation of benefit for long term and short term can help policy makers to decide whether apply the new test or not. When valuate benefit within time frame, we should concern with the change of incidence and the interest rate. These factors company with others affecting on the benefit.

* Technical value of new test: the characteristics of a test are Specificity (proportion of non-diseased individuals who will have a negative test, the more specificity the less false positive cases. High Specificity is desired when disease is serious, the treatment is risky/expensive, false positive results harmful); Sensitivity (proportion of all diseased individuals in whom the test will be positive, the more Sensitivity the less false negative cases. High Sensitivity is desired when disease is serious, the treatment is save/inexpensive, false negative results not harmful); Positive Predict Value (proportion of all positive tests which are in diseased individuals); Negative Predictive Value (proportion of all negative tests which are in non-diseased individuals).

According to the issue of specific research and to available calculation we can take one or more characteristics into consideration.

* components of outcome: due to reduction of waiting time of an on the spot malaria diagnostic test, the

outcomes are:

- reduction of external cost
- reduction of presumptive treatment
- possible reduction of self treatment
- possible reduction of drug resistance

The valuation of outcomes (outcome components) will be judged against costs (cost components) for decision to use or not a new test. Such judgment can be made in the short run or in the long run with a defined number of years.

Costing as well as evaluation should consider the annual interest rate for calculating the present value of future costs and future benefit; the annual decrease of incidence or the real annual number of tests to be performed; the annual population growth rate, it makes change in population at control area as well as in amount of malaria population with respected to incidence

1.2 Costing of Input Activities

Cost system (including both input activities and level of activities) is illustrated in figure 11.

Information required for costing 13 activities

The model requires information for costing 13 activities above mentioned as follows:

(1) Costing training of technicians includes number of technicians to be trained; number of required training days for each technician; perdiem per technician; travel cost per technician; required number of trainers; per diem per trainer; travel cost per trainer; administration cost (renting of conference room, printing, handouts, etc...) and training for quality control technicians

(2) Costing service space : depends on number of service points and cost of each service space.

(3) Costing of equipment : depends on number of service points and cost of equipment for each service point.

(4) Costing of administration for establishing a new test: It's identified by estimating the percentage of total field cost which is spent at upper levels to establishing a new test.

(5) Costing quality control: in principle, for each test they can use the same or other test to make quality control. The capital cost of quality control test depends on number of quality control points; cost of equipment for each quality control point and cost of each quality control space.

(6) Costing of salary. This item concerns with the salary for those who perform the new test. This total salary is determined by number of technicians in the field; percentage of technician time for working on the new test; monthly salary of technician in the field.

(7) Costing of annual retraining of technicians: for each test, the rate of technicians to be replaced / updated annually may be different, usually it is considered to be about 10 %.

(8) Costing of space maintenance: in this study this cost is conventional as the cost for renting the place to perform the new test. It depends on number of service points and annual renting cost per service point.

Figure 11. The Detailed Cost System

<table>
<tr><th></th><th>Establishing service points for new test</th><th>Runing a new test</th></tr>
<tr><td rowspan="3">FIELD LEVEL</td><td rowspan="2">Training technicians (1)</td><td>Salary for technicians (6)</td></tr>
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<tr><td>Preparing service space (2)</td><td>Annual maintenace of space (8)</td></tr>
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(9) Costing of annual consumables : This depends not only on the annual number of performed tests and consumable cost per test but also on cost of false positive cases related to the new test's specificity because those who get a false positive diagnosis have to take radical treatment. The concern of this study is drug consumption with respect to waiting time. The lower the specificity of the test the greater the money spent on false radical treatment.

(10) Costing of annual supervision : it depends on number of service points; supervision times per service point; supervision days per time; per-diem of supervisor; transport cost per time per supervisor.

(11) Space maintenance for annual quality control : as above mentioned, the cost of space maintenance for quality control is considered as cost of renting space, so the total space maintenance for quality control activity annually is equal to number of quality control points time annual space renting cost per quality control point.

(12) Salary for annual quality control: This depends on number of technicians working per quality control point; annual salary of technician working on quality control and working proportion the technician devotes for quality control activity.

(13) Consumables for annual quality control: These are determined by consumable costs per quality control test and number of tests under quality control (depending on number of tests performed at field level).

Assumptions for costing

The model works on assumptions as follows:

* Number of service points to be developed depends on:
  - the size of population at control area
  - the size of population in a defined area that one service point is sufficient to cover by the new on the spot malaria diagnostic technique

* Size of population under the coverage of one service point depends on the test to be used; this size should beestimated on experiences of experts.

* Number of technicians in training is equal to number of

technicians at work; it depends on:

- number of service points
- number of technicians for each service point to be estimated on the basic of experience of experts

* Technicians can work full time or part time for test performance. In case of part time working, estimation of working proportion for the test should be made on the basic of experience of experts.

* Number of trainers depends on:

- number of technicians to be trained
- ratio between trainees and trainers in each course to be estimated on training experience of experts.

* Perdiem and travel cost for trainees are different to those for trainers. Perdiem and travel cost for trainers are estimated to be equal to those for supervisors. Such perdiem and travel costs can be proposed by the malaria control programme.

* Administration rate of training cost is 10 %.

* Number of quality control points to be developed depends on characteristics of the test and the number of service points.

* Quality control rate should be defined by the malarial control programme and is expected to be 10 %.

* Administration costs are estimated as a proportion of field costs.

Notation of costs

p = population at risk
ppp = population per service point
ppcp = population per quality control point

tpp = trainees per service point
tppq = trainees per quality control point
tdp = training days per service person
tdpq = training days per quality control persons
pdj = perdiem junior for trainees for service
pdjq = perdiem junior for trainees for quality control
pds = perdiem senior for trainers for service
pdsq = perdiem senior for trainers for quality control
tpt = trainees per trainer for service activities
tpj = travel cost per person junior for trainees for service
tpjq = travel cost per person junior for trainees for quality control
tps = travel cost per person senior for trainers for service
tpsq = travel cost per person senior for trainers for quality control
adm = administration cost rate of training for service
admq = administration cost rate of training for quality control
epp = equipment cost per service point
eppq = equipment cost per quality control point
scp = space cost per service point
scpq = space cost per quality control point
ms = monthly salary of technician working at field level
lqc = labor cost quality control
sm = space maintenance cost per service point
sqc = space maintenance cost per quality control point
spc = specificity of performance test
cut = cost of unit kit of performance test
qcuc = unit cost of quality control test
npqc = number of persons per quality control point

lqc = monthly salary for quality control technician
spc = space maintenance cost per quality control point
stp = supervision times per service point per year
sds = supervision days per time
tcr = quality control rate
crt = cost of radical treatment case
psp = working proportion of service person
pcs = working proportion of quality control person
tcr = quality control rate

Calculation of costs

(1) Costing of training (tco):

tco = ctt + adc

Cost for trainees and trainers (ctt):

ctt = not * tdp * pdj (perdiem for trainees)
+ not * tpj (travel for trainees)
+ not/tpt * pds * tdp (perdiem for trainers)
+ not/tpt * tps (travel for trainers)

not = number of technicians to be trained
= nsp * tpp
nsp = number of service points
= p/ppp
not/tpt = number of trainers

Administration cost (adc):

adc = adm * ctt

(2) Costing service space (sco)

sco = nsp * scp

(3) Costing of equipment (eco)

eco = nsp * epp

(4) Costing of administration for establishing a new test (adc) assumed to be 5% of material cost and training cost at field level.

adc = 0.05 * (eco + tco)

(5) Costing of establishing quality control (esqc)

esqc = tqc + eqc + sqc

* training cost for quality control points (tqc)

tqc = notq * tdpq * pdjq (perdiem for trainees)
+ notq * tpjq (travel for trainees)
+ notq/tptq * pdsq * tdpq (perdiem for trainers)
+ notq/tptq * tpsq (travel for trainers) + adcq

notq = number of technicians to be trained
= ncp * tppq
ncp = number of quality control points
= p/ppcp
notq/tptq = number of trainers

* Administration cost of training (adcq)

adcq = admq * tqc

* equipment cost for quality control points (eqc)

eqc = ncp * ecpq

* space cost for quality control points (sqc)

sqc = ncp * scpq

(6) Costing of salary: salary for service persons = ssp

ssp = ms * not * 12 * psp

(* 12 is number of months in one year)

(7) Costing of annual retraining of technicians (art)

art = ctt * 0.1

(* percentage of technicians to be replaced/upgraded annually assumed to be 10%).

(8) Costing of space maintenance (smc)

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smc = nsp * sm
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(9) Costing of annual test at field level(cfl)

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cfl = scf + cfc
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* cost of kit test at field level (scf)

scf= i * p * tpi * cut

i= annual incidence

* annual number of positive cases = i * p
* number of tests performed per positive case (tpi): tpi = 43 - 3 * i
* number of tests = i * p * tpi/1000

* cost of false positive cases (cfc)

cfc = (1-spc) * ((i*p*tpi/1000)-(i*p))* crt

(10) Costing of annual supervision (mfc)

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mfc = nsp * stp * sds * pds (perdiem cost)
    + nsp * stp * tps (travel cost)
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(11) Costing of annual space maintenance for quality control (tsqc)

$$tsqc = sqc * ncp * 12$$

(12) Costing of annual salary for quality control (tlqc)

$$tlqc = lqc * ncp * npqc * 12 * pcs$$

(13) Costing of annual consumable for quality control (cct)

$$cct = (i * p * tpi/1000) * tcr * qcuc$$

i = Annual incidence in control area
p = population in control area
tpi= number of test per positive case
i * p * tpi/1000 = number of test is performed

Classification of cost

Total capital cost (tcc)

* Capital cost for establishing a new test at field level (cof)

cof = tco + eco * sco

* Capital cost for establishing a new test at upper levels (coqc)

coqc = adc + esqc

* Total capital cost (tcc)

tcc = cof + coqc

Total fixed cost (tfc)

* Fixed cost at field level (ffc)

ffc = ssp + art + smc

* Fixed cost at upper levels (fcqc)

fcqc = mfc + tsqc + tlqc

* Total fixed cost (tfc)

$$tfc = ffc + fcqc$$

Total variable cost (tvc)

* Variable cost at field level = cfl
* Variable cost at upper level = cct
* Total variable cost (tvc)

$$tvc = cfl + cct$$

Total cost (C)

$$C = tcc + tfc + tvc$$

1.3 Valuation of Outcomes

The introduction of a new test is intended to reduce waiting time. Outcomes from introducing a new test are the consequences of the reduction of waiting time. Expected outcomes are:

(1) Reduction of external cost

(2) Reduction of presumptive treatment cases
(3) Possible reduction of self treatment cases
(4) Possible reduction of drug resistant cases.

Information required for valuation of outcomes

The model requires information for valuation of outcomes as follows:

(1) Valuation of avoided external cost:

* number of cases (with waiting time) requiring external cost
* time cost per case
* travel cost per case
* rate of accompanying person
* daily income

(2) Valuation of avoided presumptive treatment

* number of waiting cases
* percentage of presumptive treatment among waiting cases
* cost per case of presumptive treatment

(3) Valuation of avoided self treatment

* number of cases seeking diagnosis and treatment at hospital and malaria clinic
* rate of self treatment among above mentioned cases
* cost per case of self treatment

(4) Valuation of avoided drug resistance.

Actual information is not sufficient for forecasting of future reduction of drug resistance. There is no available data in this moment in order to assess quantitative relationship between inappropriate drug consumption and drug resistance while it's strongly believed that inappropriate drug consumption leads to drug resistance.

Assumptions for valuation of outcomes

The modelling defines information for required data for valuation of outcomes on assumptions that

* the number of cases requiring external cost is equal to the number of cases requiring waiting time
* the number of waiting cases is the number of cases who have to wait for more than one day from diagnosis to radical treatment.
* the percentage of presumptive treatment depends on drug policy, eg :no presumptive treatment; treatment of fever cases; treatment of suspected cases; or prescription.
* the percentage of self treatment depends on health seeking behavior of patients, on drug availability, etc.
* waiting cases are to be estimated from incidence rate, population and current situation of malaria diagnosis and treatment, etc.

Notation for valuation of outcomes

rwt =	rate of waiting among diagnostic cases
wdp =	waiting days per person
apr =	accompanying person rate
ind =	income per day (patient)
dhs =	distance house-service point
cpk =	cost per 10km
prw =	presumptive treatment rate among waiting cases.
cpc =	cost per presumptive treatment case
rost=	rate of self treatment.
cstc=	cost per self treatment case

Calculation

(1) Value of external costs (B1)

$$B1 = ops + trc$$

* Number of waiting cases (nwt)

nwt = number of test * rate of waiting case

= (i * p * tpi / 1000) * rwt

* Number of waiting days (ttwt)

ttwt = nwt * wdp

* Opportunity cost (ops)

ops = ttwt * ind

* Number of accompanying persons (nap)

nap = nwt * apr

* Saving travel cost by users (trc)

trc = cpk * dhs/10 * (nwt + nap) * 2

(2) Value presumptive treatment (B2):

B2 = nwt * prw * cpc

(3) Value of self treatment (B3)

B3 = ncr * rost * cstc

* Number of cases seeking diagnosis at hospitals and malaria clinics (ncr).

ncr = number of diagnosis cases - number of waiting cases

= (i * p * tpi) - nwt

Total benefit (B)

$$B = B1 + B2 + B3$$

Equation for estimation benefit/cost ratio

$$B/C = \text{Benefit-cost Ratio}$$

The main equation is the estimation of benefit/cost ratio on cost benefit analysis concepts. The development of a computerized model should be done on the basis of assumptions as follows:

* Costing and evaluation should be done within a time frame to be defined for the long run (5 years or 10 years) or for the short run (1 to 4 years).

* The costing of annual recurrent cost and the valuation of annual outcomes should consider the inflation rate

* The costing of annual variable cost and the valuation of annual outcomes should consider the decrease rate of malaria incidence.

* The population growth should be considered for the estimation of quantities related to population in the model.

* The valuation based on positive cases should consider the sensitivity, the specificity and the predictive value of the test in use.

1.4 Computer Programme

A computer program was developed based on Foxpro software. The details are given in appendix 1.

Database and assumptions for running program are Population of control area in the first year applying the new test; Population growth rate during the time applying the new test; Incidence of the first year applying the new test; Decrease rate of incidence during the time applying the new test and Interest rate during the time applying the new test.

2. Testing the Simulation Modelling

Testing the simulation modelling means testing the above computer program by using required data. Testing the feasibility of the simulation modelling was done on data collected from the Malaria Control Program in Thailand and from the application of developing malaria diagnostic tests, mainly of the ParaSight test.

Testing the simulation modelling should consider to the Malaria endemicity in Thailand, Malaria service in Thailand and Input data for running the computer modelling.

2.1 Malaria Endemicity in Thailand

On malaria epidemiology concepts, Thailand has been divided into 3 operational areas since 1991 comprising control, preintegration and integration areas. The control area has to be divided into "control area with transmission" and "control area without transmission". Control area with transmission is mainly the forest, foothill and border area. Control area with transmission can be divided into 2 categories:

- Perennial transmission area: indigenous cases are reported throughout the year or at least 6 months/year.
- Periodic transmission area: indigenous cases are

reported 5 months/year or less.

In both perennial and periodic transmission areas, vector control, active and passive case detection and treatment are emphasized. Control area without transmission is the susceptible area to transmission due to the presence of vector and population movement that may cause malaria resurgence or even epidemics. Control area without transmission can also be divided into 2 categories:

- High risk area: no transmission within 3 years, principal or secondary vectors may be found.
- Low risk area: no transmission within 3 years, principal or secondary may not be found, but suspected vectors may be found.

In both high and low risk areas, vector control is less important than in control area with transmission. Full surveillance scheme is the most important activity. Passive case detection and prompt treatment are basic tactics.

Pre-integration area: a district wide area that has been in low risk area for at least 3 years. Local health services (hospitals and health centers) are able to conduct case detection, treatment and case investigation.

Integration area: a province wide area that has been in pre-integration area for at least 3 years. Province health services are capable to manage all activities concerning malaria.

2.2 Malaria Service in Thailand

The study of malaria services in Thailand provides information on levels of cost and on service points undertaking malaria diagnosis and treatment.

The Malaria Control Program is a division of the Department of Communicable Disease Control of the Ministry of Public Health. There are activities at country level and activities at field level. At

country level the program comprises 5 regions, 33 zones and 302 sectors.

The Malaria Division is responsible for General Management, Laboratory Services, Vector Control, Health Education and Training, Epidemiology, Entomology and Applied Research.

Field level is responsible for, Active and passive case detection, Presumptive treatment of symptomatic cases with suspected history and Radical treatment of parasite positive cases. At field level, there are 515 Malaria Clinics, 38,000 Village Malaria Volunteers, Health Centers, Hospitals and other Health Institutions that conduct passive case detection for blood slide taking and treatment, Mobile Malaria Clinics (14,860 times/year in 1992), Fixed Schedule Malaria Clinics and House Visiting that conduct active case detection for blood slide taking and treatment.

Laboratory examination has to provide high quality blood examination from various sources of activity with an accuracy not less than 99% and to provide examination service and treatment for the service. 11 activities of laboratory examination are as follows:

(1) Blood film preparation:
-Single use disposable lancets
-Blood smear and coding, one sample per glass slide
-Blood staining by 10% Giemsa, 10 minutes
-Disposing of used materials

(2) Blood film examination:
-Stress on rapid examination and treatment
-Assistance to laboratories that have a trend to build a back-log.
-Priority examination

(3) Blood film interpretation:
-Examination method, 100 microscopic fields or 5-6 minutes.
-Examination to rule out mixed infection

(4) Blood film report:
-System of reporting
-Stage and species reporting
(5) Quantity control of blood film examination
-Examination rate, 30-60 slides per day
(6) Quality control of blood film examination
-10% checking (Neg. + Pos at regional)
-10% rechecking (Neg. + Pos. at headquarter)

(7) Provision of training courses for microscopists

(8) Supervision of laboratory activities

(9) Analysis and improvement of microscopist efficiency.

(10) Provision of standard policy for laboratory services.

(11) Implementation and promotion of research on diagnostic methods.

Laboratory activities are based on 875 microscopists, 1 headquarter laboratory, 5 regional laboratories, 33 zone laboratories, 515 malaria clinics and 148 health centers that conduct blood film examination.

On the basic of above data, there are 2 levels of cost. First level (field level) is responsible for Laboratory establishment (space, microscopes...); Training and retaining of technicians, Case detection; Microscopic examination (manpower, chemicals...) and Treatment. Second level (Higher level) is responsible for Checking and rechecking of 10% of slides examined by field level and Supervision.

In 1992, there were 5,575,292 blood slides collected from various sources: 672,524 by Malaria Clinics; 680,866 by Village Malaria Volunteers; 1,355,176 by Health Institutions and 2,867,716 by active

case detection and health centers.

Patients at malaria clinics and health institutions have not to wait for long from diagnosis to treatment. These places can be considered as on the spot diagnosis with the existing diagnostic technology. Patients whose blood slides are taken by Village Malaria Volunteers, Health Centers, and Active Case Detection Agents should wait for some time from diagnosis to treatment. 63.64% (3,548,582/ 5,575,292) or about 2/3 of patients have waiting time (>1 day).

2.3 Input Data

Information required for costing of inputs are taken from areas as follows:

* Malaria endemicity in Thailand for estimation of the population at risk and malaria incidence;

* Malaria services in Thailand for the estimation of service levels and service points;

* ParaSight test and other malaria diagnostic tests for the elaboration of cost system and the identification of component costs.

Information required for valuation of outcomes are taken from areas as follows:

* Waiting time from diagnosis to treatment: external cost.

* Treatment strategy and presumptive treatment

* Community behaviour and self treatment

* Inappropriate drug consumption and drug resistance

Required assumptions are as follows:

* Population in control area at first year applying the new

test: 40,000,000.

* Population growth rate during the time applying the new test: on the basic of data from Population projection for Thailand 1980-2015 (1991), the population growth rate is estimated to be 0.85%. Assuming that the population growth rate in the control area is similar to that in the whole country as being 0.85 %.

* Incidence of the first year (1992) applying the new test: 3.7 per 1,000 population

* Decrease rate of incidence during the time applying the new test: on the basic of data from Annual report of Malaria Division (1982-1992), the decrease rate of incidence is estimated to be 0.14 annually.

* Interest rate during the time applying the new test: it is estimated to be 7 % per year.

Data for running computer programme:

Data in 1992 (first year) is used for running program.

(1) Population in control area (p):

$$p = 40,000,000$$

According to data of Malaria Division, Population in control area in 1992 was 40,593,857. For making the calculation is more convenient we used the population in control area as being 40,000,000.

(2) Population per service point (ppp):

$$ppp = 8,000$$

This study takes the size of population of 1 tambon (8,000 population) assuming that 1 trained person can perform the ParaSight test on the spot for any case seeking malaria diagnosis in the tambon.

(3) Population per quality control point (ppcp):

ppcp = 80,000

Assuming that suspected cases should be checked by the blood smear microscopic examination at quality control points. This study takes the population of 1 district (80,000) assuming that 1 microscopist at district hospital can examine 10% of tests performed at tambon level.

(4) Trainees per service point (tpp):

tpp = 1.

As above mentioned, 1 trained person is sufficient for 1 tambon.

(5) Trainees per quality control point (tppq):

tppq= 1.

As above mentioned, 1 microscopist is sufficient for 1 district.

(6) Training days per service person (tdp):

tdp = 0.5.

ParaSight test is very easy. It takes not more than 1 hour for training, tdp should not be more than one half day.

(7) Training days per quality control person (tdpq):

tdpq= 0.

We assume that existing microscopists are mobilized for this activity and do not require training.

(8) Trainees per trainer for service (tpt):

tpt = 25.

On experience of the Malaria Division, a training course on ParaSight test should not have more than 25 trainees.

(9) Trainees per trainers for quality control(tptq):

tptq =15.

On experience of the Malaria Division, a training course for microscopists should not have more than 15 trainees.

(10) Perdiem for service persons (pdj):

pdj = 50.

Training course for performers of ParaSight test can be done at community level. Perdiem can be very low. On experience of the Malaria Division, it should not be more than 50 Baht.

(11) Perdiem for quality control persons (pdjq):

pdjq= 100. (Source: Malaria Division).

(12) Perdiem for trainers for service (pds):

pds = 120 (Source: Malaria Division).

(13) Perdiem for trainers for quality control (pdsq):

pdsq = 150. (Source: Malaria Division).

(14) Transport for trainees for service (tpj):

tpj = 0.

Training course on ParaSight test can be done at field level close to the houses of trainees. there is no need for transport cost.

(15) Transport for trainees for quality control (tpjq):

tpjq = 50.

Training courses for microscopists can be done at district site. On experience of the Malaria Division, transport cost for trainees should not be more than 50 Baht.

(16) Transport for trainers for service (tps):

tps = 200. (Source: Malaria Division).

(17) Transport for trainer for quality control (tpsq):

tpsq = 200 (Source: Malaria Division).

(18) Administration cost rate for training for service (adm):

adm = 10% (Source: Malaria Division)

(19) Administration cost rate for training for quality control (admq):

admq = 10% (Source: Malaria Division).

(20) Equipment cost per service point (epp):

epp = 0.

The ParaSight test does not require major equipment.

(21) Equipment cost per quality control point (eppq):

eppq = 0.

Microscopes in current use in hospitals and malaria clinics are sufficient to undertake this supplementary task. There is no need for supply of more equipment for quality control points.

(22) Space cost per service point (scp):

scp = 0.

The Parasight test does not require space.

(23) Space cost per quality control point (scpq):

scpq = 0.

Space for microscope already exists and does not require for extension.

(24) Monthly salary of service person (ms):

ms = 4,000.

In this program, assume that firstly Parasight test is done by health worker. The average of health worker's salary is 4,000/month. If Village Malaria Volunteers (VMV) perform the test the salary will be equal to 0.

(25) Space maintenance cost of service point (sm):

sm = 0.

Because the performance of Parasight test do not require space there is no need for space maintenance.

(26) Test specificity (spc):

spc = 85%.

ParaSight test has just been developed so it's specificity is reported differently by various authors from 80% to 94 %. We take acceptable figure as being 85% .

(27) Cost of unit test (cut):

cut = 25.

The cost of ParaSight kit per test has not been officially defined. For calculation we take it as being 25 Baht.

(28) Cost of unit quality control test (qcuc):

qcuc = 7 (Source: Malaria Division).

(29) Labor cost quality control/month (lqc):

lqc = 6,000 (Source: Malaria Division).

(30) Space maintenance cost per quality control point (sqc):

sqc = 500 (Estimated by authors).

(31) Supervision times per service point (stp):

stp = 0.

The technique of ParaSight is simple and easy to interpret results so no need to supervise.

(32) Supervision days per time (sds):

sds = 0. (The same as above explained).

(33) Quality control rate (tcr):

tcr = 10 % (Estimated by authors).

(34) Waiting days per case (wdp):

wdp = 5.0.

From information of Thailand country report (Tanpradist et al, 1993), we calculated average waiting time in table 1:

Table 1. Average Waiting Time in 1992

Institution Number of cases		MC	MVV	HC	Others
Absolute amount		671524	680866	1355176	2867716
Percentage of waiting day equal to	1.5* (0-3)	99.9	11.4	87.1	90.9
	5.5* (4-7)	-	88.0	10.2	7.7
	10* (6-14)	-	0.3	0.5	0.9
	14* (>14)	-	0.3	2.1	0.5
Sub. total waiting days		1006278	3902043	6602419	971954

Total waiting days: 21,223,695

Total waiting cases: 4,241,300

Average waiting days: 21,223,695/4,241,300 = 5.0 days/case.

Note: The figure with star (*) is estimated from the upper figure in the bracket which are reported by Malaria Division (Tanpradist, 1993).

(35) Rate of waiting cases among diagnostic cases (rwt):

rwt = 0.76. From data of Malaria Division (1993), number of waiting cases in 1992 were 4,241,000 among 5,575,282 diagnosis cases:

rwt = 4,241,000 / 5,575,282 = 0.76

(36) Accompanying rate (apr): apr = 0.05 (Source: Malaria Division).

(37) Income day (ind): ind = 65.1. On data from the study "Income distribution and malnutrition in Thailand" (Ikemoto, 1994), income per capita of Thailand in 1992 was divided to 10 level with the range from USD 200 to USD 9414. We assume that the average income of population is a little upper than medium level, the fourth level with USD 815 in 1992. If one year exists of 313 working days and exchange rate is 25 Baht for 1 USD, the real income will be:

$$(815 * 25) / 313 = 65,10 \text{ (Baht)}$$

(38) Distance from house to service point (dhs): dhs = 5km. (Source: Malaria Division).

(39) Transport cost per 10 km (cpk): cpk = 20. (Source: Malaria Division).

(40) Rate of presumptive treatment among waiting cases (prw): prw = 0.44. The number of presumptive treatment cases in 1992 were 1,847,095 (Malaria Division source) and the number of waiting cases in 1992 were 4,241,300 (Source :Thailand country report, 1993, Dr. Surang Tanpradist, p. 10). Therefore, prw = 1,847,095 / 4,241,300 = 0.44.

(41) cost per presumptive treatment case (cpc): cpc =4.74. According to Malaria Division, the treatment scheme for presumptive treatment consists of 2 Sulfadoxine-Pyrimethamine tablets and 2 Primaquine tablets. The cost is:

$$cpc = (2 \text{ S/P} * 2.14 \text{ B}) + (2 \text{ Pri} * 0.2 \text{ B}) = 4.74 \text{ Baht}$$

(42) Rate of self treatment among patients attending hospitals and malaria clinics (rost): rost = 0.78. From data of the review "Some Epidemiological Aspects of Drug Resistant falciparum Malaria in Thailand" (Siriporn, 1993) rate of self treatment of the cases visiting malaria clinics was 78%.

(43) Cost of self treatment case (cstc): cstc= 100 (Source: Malaria Division).

(44) Cost per radical treatment case (crt): crt = 25 (Source: Malaria Division).

(45) Working proportion of service persons (psp): psp = 0.12. Assuming that 1 health worker can perform 36 tests a day. In 1 year, 1 health worker can perform:

36 tests * 250 days = 9,000 tests

There is a need of 5,500,000 : 9,000 # 600 health workers working totally for the test. The program has in all 40,000,000 : 8,000 = 5,000 health workers trained for the test. Therefore, only 600: 5,000 = 0.12 of their working time is for the test.

(46) Working proportion of quality control persons (pcs): pcs = 0.05. Assuming that 10% of the cases should be checked by microscopists at district laboratories:

0.1 * 5,000,000 tests = 500,000 cases

Assuming that 1 microscopist can examine 60 smears in 1 day and 60 * 250 days (year) = 15,000 smears/year

There is a need of 33 microscopists working totally for the test. While the program has 40,000,000/80,000= 500 microscopists. Therefore, only 33/500 = 0.066 # 0.05 of their working time is for quality control.

(47) The number of tests to be performed (tpi): tpi = 33.55 = 43 - 3 * 3.15. tpi will be an equation to be estimated by linear regression (with positive cases) as follows:

Year	1988	1989	1990	1991	1992
Incidence (X)	6.71	5.40	5.18	3.74	3.15
Test positive	23	26	26	32	33

Source: Malaria Division (Tanpradist, 1993)

Y = number of tests per positive cases.

From the calculation of linear regression between incidence X and number of tests per positive cases Y, equation may be made as follows:

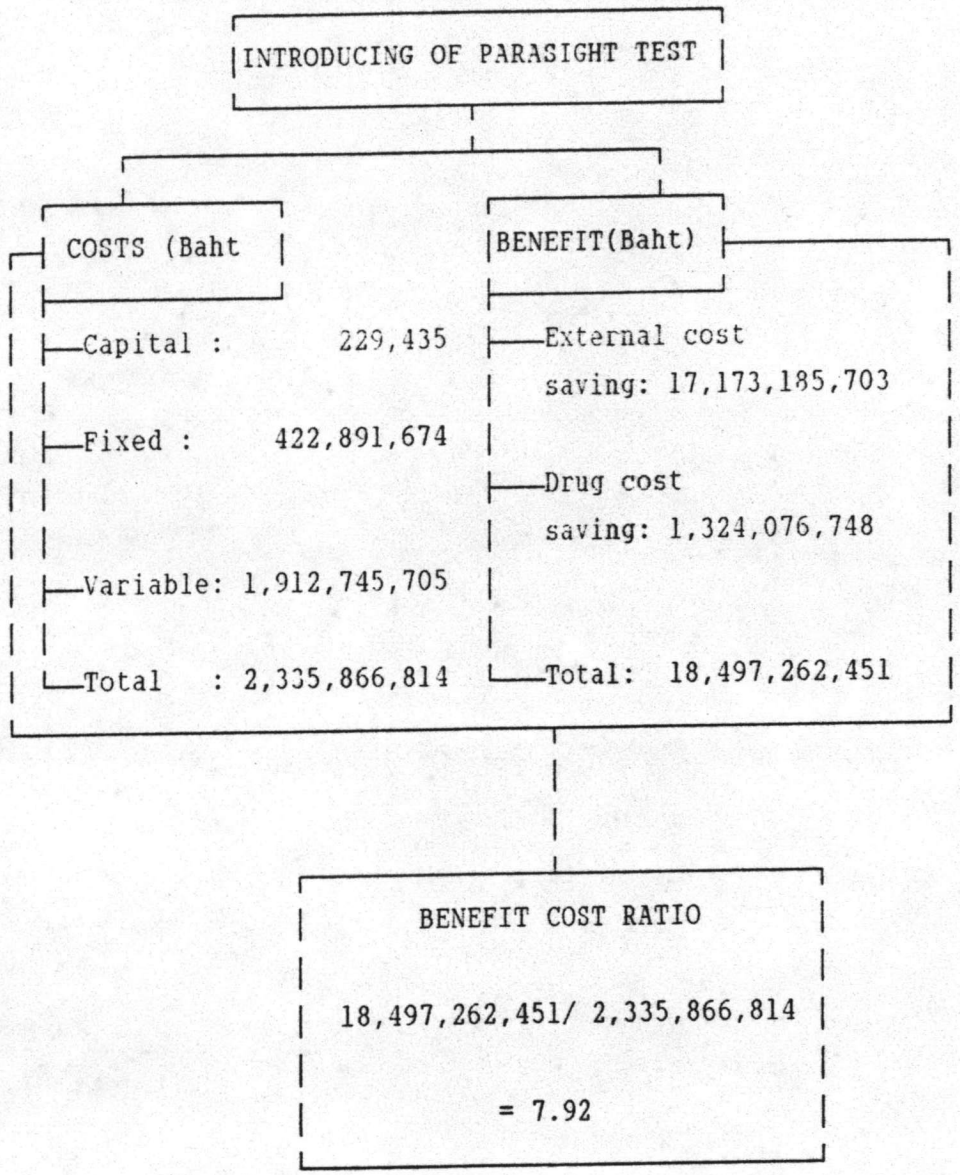
$$Y = 42.52 - 3X; \quad r = -0.98$$
$$= 43 - 3X$$

This means the maximum number of tests to be performed per positive case should not be higher than 42.

2.4 Programme Output

From the above input data, output data (Baht) for 10 years are as follows: (Figure 12)

Figure 12. Program Outputs of ParaSight Test



This means that for every 1 money unit we spend we can gain nearly 8 money units of benefit. The above output data vary with the variation of input data. It is to be noted that while reduction in drug usage represents a substantial saving, the greater contribution to benefit is from reduced external costs.